PICOTEST®

M3530A 6 1/2 Digits 4.3" Economy Digital Multimeter

User's Manual

Version: 1.1

Table of Contents

1 General Information

This section contains general information about PICOTEST M3530A Multimeters. 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
8. Manufacturer Information
9. Specifications

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

1.1 Feature Overview

M3530A is a 6 1/2 digits multimeter. It has…

- Best performance/price ratio
- High-speed sampling rate (75000 Rdgs/sec. at M3530A NPLC 0.0008).
- Direct Thermocouple Measurement (Built-In Cold Junction Compensation to improve Accuracy)
- 4.3-inch Color Graphical Display, Dual Measurement & Dual Display (Including Thermocouple Measurement)
- Capacitance Measurement
- Several Measurements & Mathematic Functions
- Wide Range Current Measurement (Up to 10A)
- DCV Accuracy (0.007% in 1 year)
- Plug & Play Interface: Built-In USB
- High Storage Memory (Up to 1.5M Readings) --
- Free Application Software

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

In addition, the M3530A provides wide ranges for general measurements, such as…

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

Some additional capabilities of M3530A include:

- Full Math Functions - Percent, Average, Null, Limits, MX+B, dB & dBm.
- Resolution Adjustment – 0.0008, 0.0016, 0.0024, 0.008, 0.02, 0.06, 0.2, 1, 10 & 100 NPLC
- USB & LAN(Optional),GPIB (Optional) remote control interface.
- Through M3530A 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 Advanced Setup

To access the following setup quickly, there are some hot keys listed in the **Table 1** or carefully read **Chapter 3** to operate. The hint is to press a soft or a hard key below for two seconds except the single RUN/STOP, the ENTER, and the SHIFT button.

Table 1

Advanced Key Operation			
	Key	**Method**	**Result**
Soft-Key	**Range**	Key pressed for 2 s	Quickly provide a range selection.
	Integration/ Bandwidth/ Aperture	Key pressed for 2 s	Quickly enter the relative selection.
	Measure (Freq)	Key pressed for 2 s	Quickly enter the frequency setup.
	Null	Key pressed for 2 s	Quickly enter, and require to input an impedance value.
	Filter	Key pressed for 2 s	Quickly enter the relative setup, and require to input a count value.

	Math	Key pressed for 2 s	Quickly enter the math format selection.
	Read Hold	Key pressed for 2 s	Quickly enter the reading hold window selection.
	Trigger	Key pressed for 2 s	Quickly enter the sample count setting as trigger once.
Hard-Key	**DISPLAY**	Key pressed for 2 s	Quickly take a Screenshot of the present display.
	MENU	Key pressed for 2 s	Quickly enter to an optimization mode. (the highest effect)
	RUN/STOP	Key pressed for 2 s	The continuous mode is required, and quickly run an immediate measurement.
	RUN/STOP	SHIFT + RUN/STOP	Quickly enter the acquire setup.
	SINGLE	Key pressed for 2 s	The continuous mode is required, and quickly run the measurement once.
	EXIT	Key pressed for 2 s	Quickly clean all setup over the Soft-Keys.
	DCV	Key pressed for 2 s	Quickly enter the relative setup.
	DCI	SHIFT + DCV key pressed for 2 s	Quickly enter the relative setup.
	ACV	Key pressed for 2 s	Quickly enter the relative setup.
	ACI	SHIFT + ACV key pressed for 2 s	Quickly enter the relative setup.
	Ω2W	Key pressed for 2 s	Quickly enter the relative setup.
	Ω4W	SHIFT + Ω2W key pressed for 2 s	Quickly enter the relative setup.

Advanced Key Operation

	Key	Method	Result
Hard-Key	**FREQ**	Key pressed for 2 s	Quickly enter the relative setup.
	RATIO	SHIFT + FREQ key pressed for 2 s	Quickly enter the relative setup.
	CONT	Key pressed for 2 s	Quickly enter the relative setup.
	DIODE	SHIFT + CONT key pressed for 2 s	Quickly enter the relative setup.
	TEMP	Key pressed for 2 s	Quickly enter the relative setup.
	CAP	SHIFT + TEMP key pressed for 2 s	Quickly enter the relative setup.
	Operation Lock	SHIFT + EXIT	The operation will be locked. Doing the same procedures will unlock it.

1.3 Warranty Information

If the equipment is used in a manner not specified by the manufacturer, the warranty 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 doesn't include consumptive parts such as fuses, buttons and relays, and doesn't cover defects caused by improper installation, improper or insufficient maintenance, unauthorized modification, improper operation, ignorance of environmental specifications, 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

- Our warranties don't cover any damage resulting from unauthorized modification or misuse.
- 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.
- Our warranties do not apply on any direct, incidental, special, or consequential damages.
- 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.

1.4 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.

1.4.1 Upkeep of M3530A

- Although M3530A DMM is very durable and weather resistant, care should be taken not to expose it to severe impact or pressure.
- Keep M3530A far from water and damp environment.
- Calibration will be taken every year. Please contact with your local service representative for more information.
- If the incorrect display or abnormal beeps occurred you should stop using the equipment at once.
- Do not use the Meter around explosive gas or inflammable vapor.
- Wipe the surface of M3530A multimeter with a piece of dry and clean cloth.

1.5 Safety Information

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

To avoid electric shock or personal injury, 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 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.
- 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.
- Not to position the equipment to make it difficult to operate the disconnection device.
- Use only PICOTEST specified power cord for country of use or one with equivalent ratings .
- When replacing power fuses, use only the same type and same rating as specified (250V/250mAT)

1.6 Symbols and Terms

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

⚡ 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 M3530A specifications are included in Appendix A.

1.7 Inspection

Your product package is supplied with the following items:

- One M3530A Multimeter unit. (88.3[H] x 212.8 [W] x 272.3 [D] mm, approx. 2.43 Kg)
- One power line cord.
- One USB cable.
- One set of standard test leads[1]

- One spare power fuse
- Optional accessories (According to the Table 1-1) as you ordered.

1. M3530A is provided with a Standard Test lead set, described below.

Test Lead Ratings:

IEC 61010-031 CAT III

Operating Voltage: 1000V DC

Current: 10 Amperes

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.

1.8 Options and Accessories

The following accessories are able to be used with each model. Please refer to **Table 1-1**.

Table 1-1

Part Number	Part Name
MFCR0001	Multifunction communiction card
M3500-opt04	GPIB Card
M3500-opt06	RS-232 Card
M3500-opt07	Kelvin Probe
M3500-opt08	4-Wired Test Leads
M3500-opt10	Shorting Plug
M3500-opt11	K-Type Thermocouple

1.9 Manufacturer Information

Company: Picotest Corp.,

Address: 5F-1, 286-9, Hsin Ya Rd, Chien-Chen Zone, Kaohsiung, Taiwan

TEL: +886-7-815-7183

FAX: +886-7-8158312

Website: www.picotest.com.tw
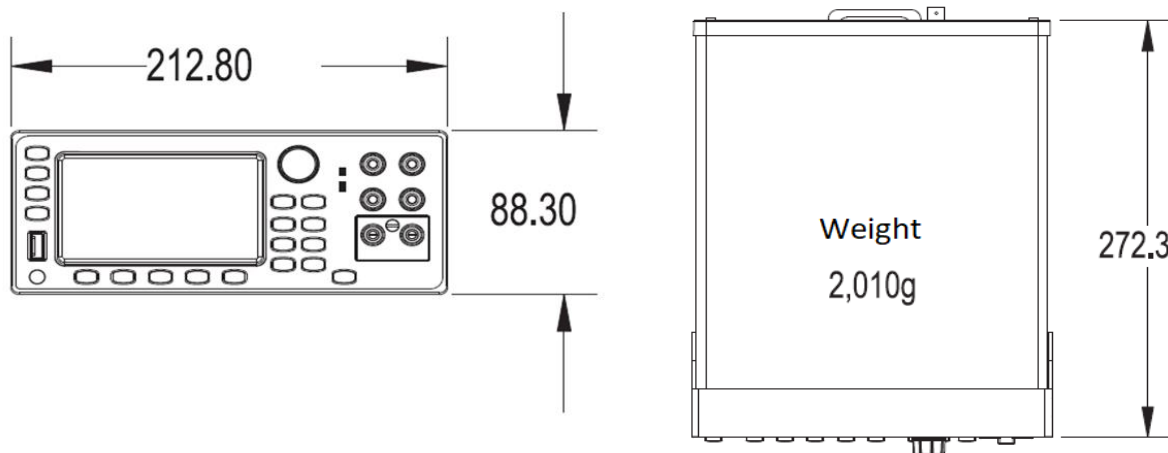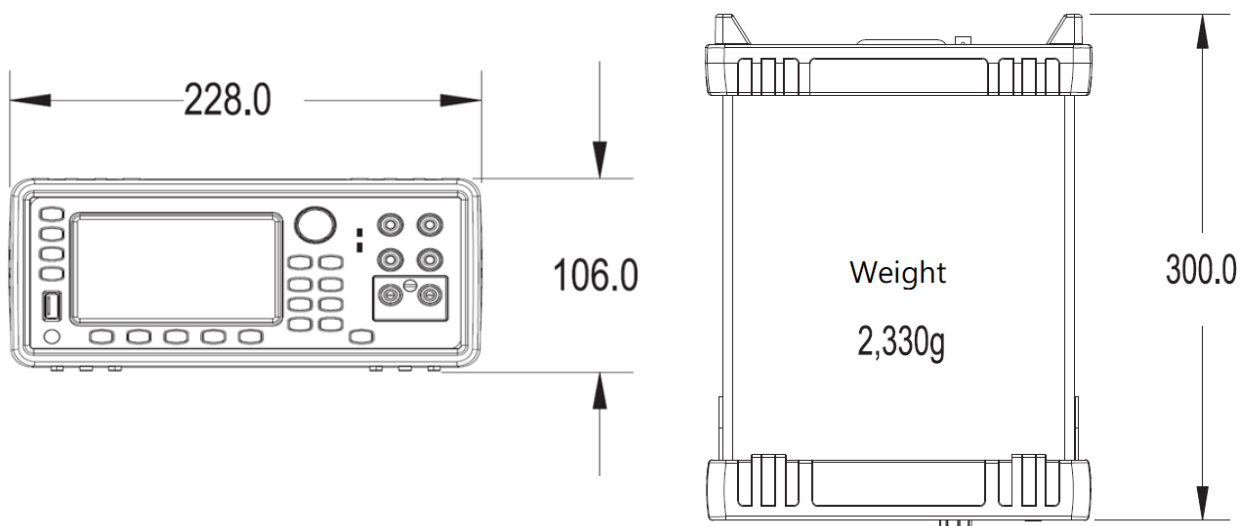
Email: sales@picotest.com.tw

1.10 The M3530A's Dimension and Weight

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

1. The dimension without the handle and the front & Rear Bumpers is in the following Picture 1. (LxWxD – 212.8x88.3x272.3 mm)

2. The dimension with the front & Rear Bumpers, but without the handle is in the following Picture 3. (LxWxD – 228x106x300 mm)

1.11 Specifications

<table>
<tr><th colspan="5">DCV

Accuracy ± (% of reading + % of range)[1]</th></tr>
<tr><th>Function</th><th>Range[2]</th><th>Resolution</th><th>Input Resistance</th><th>1 Year (23°C ± 5°C)</th></tr>
<tr><td rowspan="5">DC Voltage[3]</td><td>100.0000 mV</td><td>0.1µV</td><td>> 10GΩ</td><td>0.0080 + 0.0020</td></tr>
<tr><td>1.000000 V</td><td>1.0µV</td><td>> 10GΩ</td><td>0.0080 + 0.0010</td></tr>
<tr><td>10.00000 V</td><td>10µV</td><td>> 10GΩ</td><td>0.0070 + 0.0010</td></tr>
<tr><td>100.0000 V</td><td>100µV</td><td>10MΩ</td><td>0.0120 + 0.0020</td></tr>
<tr><td>1000.000 V</td><td>1mV</td><td>10MΩ</td><td>0.0200 + 0.0030</td></tr>
</table>

<table>
<tr><th colspan="5">DCI

Accuracy ± (% of reading + % of range)</th></tr>
<tr><th>Function</th><th>Range</th><th>Resolution</th><th>Shunt Resistance</th><th>1 Year (23°C ± 5°C)</th></tr>
<tr><td rowspan="7">DCI
(DC Current)</td><td>100.0000µA typ</td><td>100pA</td><td>105Ω</td><td>0.050 + 0.025</td></tr>
<tr><td>1.000000mA</td><td>1nA</td><td>105Ω</td><td>0.050 + 0.020</td></tr>
<tr><td>10.00000mA</td><td>10nA</td><td>5.1Ω</td><td>0.050 + 0.020</td></tr>
<tr><td>100.0000mA</td><td>100nA</td><td>5.1Ω</td><td>0.050 + 0.010</td></tr>
<tr><td>1.00000</td><td>1µA</td><td>0.1Ω</td><td>0.150 + 0.020</td></tr>
<tr><td>3.0000</td><td>10µA</td><td>0.1Ω</td><td>0.200 + 0.030</td></tr>
<tr><td>10.0000</td><td>10µA</td><td>0.005Ω</td><td>0.250 + 0.050</td></tr>
</table>

[1] The M3530A's specifications are for 1-hour warm-up condition, autozero on, 10PLC and they're relative to calibration standards. For M3530A specification information, check on the Picotest website.

[2] Measurements over 20% at all DCV/DCI ranges are allowable, but at the ranges of 1000V DCV, 3A & 10A DCI.

[3] a. Use continuous integrating A/D converter.
b. Input bias current: less than 30 pA at 25ºC.
c. ADC Linearity (10V range): 0.0002% of Reading + 0.0001% of Range.
d. Input protection: 1000 V at all ranges.
e. Input Impedance: 100mV to 10V Ranges: Selectable: (>10GΩ or 10MΩ) in parallel with <400pF. 100V to 1000V Ranges: 10MΩ in parallel with <400pF.
f. Common Mode Current: <600nA peak-peak at 50Hz or 60Hz
g. Earth Isolation: 500Vpeak > 10GΩ and <300pF any terminal to chassis

2WΩ/4WΩ				
Accuracy ± (% of reading + % of range)				
Function	Range	Resolution	Test Current	1 Year (23°C ± 5°C)
2WΩ/4WΩ[4]	100.0000 Ω	100μΩ	1 mA	0.020 + 0.005
	1.000000 KΩ	1mΩ	1 mA	0.020 + 0.002
	10.00000 KΩ	10mΩ	100μA	0.020 + 0.002
	100.0000 KΩ	100mΩ	10μA	0.020 + 0.002
	1.000000 MΩ	1Ω	10μA	0.020 + 0.004
	10.00000 MΩ	10Ω	1μA	0.010 + 0.004
	>=100.0000 MΩ	100Ω	1uA|10 MΩ	1.500 + 0.005

Diode & Continuity				
Accuracy ± (% of reading)				
Function	Range	Resolution	Test Current (±5%)	1 Year (23º C±5º C)
Diode Test	10.0000V	10μV	1mA	0.020 + 0.020
Continuity(2W)	1000.000Ω	10mΩ	1mA	0.020 + 0.030

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[4] **Resistance Measurement:**
  a. **To use 2-Wire Ω Measurement, the Null math function must be enabled.**
  b. **Measurements over 20% at all ranges are allowable.**
  c. **The range of 100MΩ is only for 2-Wire measurement, available up to 1GΩ.**
  d. **Max. 4-Wire Lead Resistance: 10% of range per lead for 100Ω, 1KΩ, and 10 KΩ ranges; 1KΩ per lead for all other ranges.**
  e. **Input protection: 1000 V at all ranges.**

ACV/ACI[5]				
Accuracy ± (% of reading + % of range)				
Function	**Range[6]**	**Resolution**	**Frequency (Hz)**	**1 Year (23°C ± 5°C)**
ACV (TRMS Voltage)[7]	100mV	1µV	10 -20K	0.12 + 0.05
			20k -50K	0.25 + 0.05
			50k-100K	0.65 + 0.08
			100k-300K	4.80 + 0.80
	1V – 750V	10µV – 1mV	10 -20K	0.12 + 0.04
			20k -50K	0.25 + 0.05
			50k-100K	0.65 + 0.08
			100k-300K	4.80 + 0.80
ACI (TRMS Current)	100µA – 100mA	100pA – 100nA	10 -1K	0.20 + 0.04
			1K~5K	1.00 + 0.10
	1A	10µA	10~1K	0.20 + 0.04
			1K -5K	1.00 + 0.10
	3A	100µA	10-1K	0.30+ 0.06
			1K -5K	1.50 + 0.15
	10A	100µA	10~1K	0.50 + 0.12
			10K-5K	2.50+ 0.20

Frequency & Period			
Accuracy ± (% of reading)			
Function	**Range**	**Frequency (Hz)**	**1 Year (23º C±5º C)**
Frequency	0.1V to 750V	10 -40	0.03
		40 -300K	0.02

[5] **The Specifications are under the test conditions, 5.5 digits, 1-hour warm-up, 3 Hz Bandwidth, and sine wave input.**

[6] **Measurement over 20% at all ranges is allowable, but the range 750 ACV, 3A , 10 ACI**

[7] **The Specifications are under the test condition, sine wave input>5% of range. When the inputs are within 1% to 5% of range and<50 KHz, the error, 0.1% of range must be added. For inputs within 50 KHz to 100 KHz, the 0.13% of range must be added.**

a. **Crest Factor(excludes sine wave): Crest factors of up to 3:1 at full-scale input.**
b. **Volt-Hertz Product: ≤ 8 x 10^7V-Hz at Range 750V.**
c. **Common Mode Rejection Ratio: >70dB, for 1kΩ unbalance in LO lead**
d. **Input Impedance: 1MΩ, in parallel with <100pF**
e. **Input Protection: 750VAC/1100Vpeak**
f. **Maximum DCV: 400V on any ACV range**

Capacitance
Accuracy ± (% of reading + % of range)

Function	Range	Test Current	1 Year Accuracy
Capacitance[9]	1nF	10µA	0.50 + 0.50
	10nF	10µA	0.40 + 0.10
	100nF	100µA	0.40 + 0.10
	1µF	100µA	0.40 + 0.10
	10µF	100µA	0.40 + 0.10
	100µF	1mA	0.40 + 0.10
	1mF	1mA	0.40 + 0.10
	10mF	1mA	0.80 + 0.10

Temperature
Accuracy ± (% of reading)

Function	Type	Range 1 Year (23º C±5º C)
RTD, Thermistor, & Thermocouple[8]	PT100 (DIN/IEC 751)	Probe Accuracy + 0.05 °C
	5kΩ Thermistor	Probe Accuracy + 0.1 °C
	K/J/T/E/N	Probe Accuracy + Reference Junction Accuracy + 0.3 °C
	B/C/R/S	Probe Accuracy + Reference Junction Accuracy + 0.5 °C

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[8] **The measurement accuracy excludes the error of test leads.**
[9] **The Null function must be used.**

1.12 General Specifications

item	Limitation & description
Power Supply	100~240VAC
Power Line Frequency	50/60/400 Hz
Power Consumption	30 VA MAX
Operating Environment	0 ℃ to 50 ℃
Operating Humidity	Maximum relative humidity 80% for temperature up to 31 ℃ decreasing linearly to 50% relative humidity at 40℃
Storage Temperature	- 40 ℃ to 70 ℃
Operating Altitude	Up to 3000m
Bench Dimensions (WxHxD)	88.3mm x 212.8mm x 272.3mm
Weight	2.43 kg
Safety	IEC61010-1:2010/EN61010-1:2010 (3nd Edition) IEC61010-2-030:2010/EN61010-2-030:2010 (First Edition) Measurement CAT II 300V Pollution Degree 2
EMC	EN IEC 61326-1:2021 EN IEC 61326-2:2021 **EMI:** CISPR 11:2015 +A1:2016+A2:2019,Class A IEC61000-3-2:2019+A1:2021 IEC61000-3-3:2013+A1:2019+A2:2021+AC:2022 **EMS:** IEC61000-4-2:2008 IEC61000-4-3:2020 IEC61000-4-4:2012 IEC61000-4-5:2014:+A1:2017 IEC61000-4-6:2023 IEC61000-4-8:2009 IEC61000-4-11:2020

2 Overview of M3530A

This chapter will give you an overview of M3530A features and guide you through the basics of these DMMs.

2.1   Setting up Your M3530A

The purpose of this section is to prepare you for using M3530A . You may want to check if you have all the parts with your multimeter. This equipment is handled and inspected professionally before shipping out to our customers. If you find any damaged or missing parts, please contact your local service representative or distributor 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)
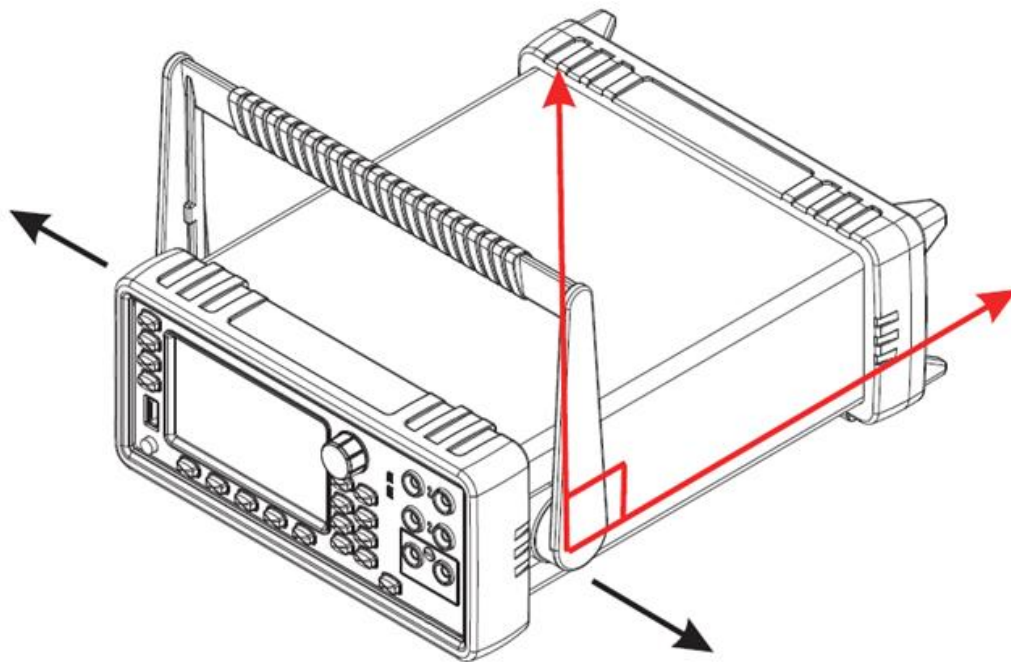Pull slightly outward on both sides of the handle and slowly rotate it up as shown as **Figure 2-1.**

Figure 2-1

【Step 2】(Pull out the handle)

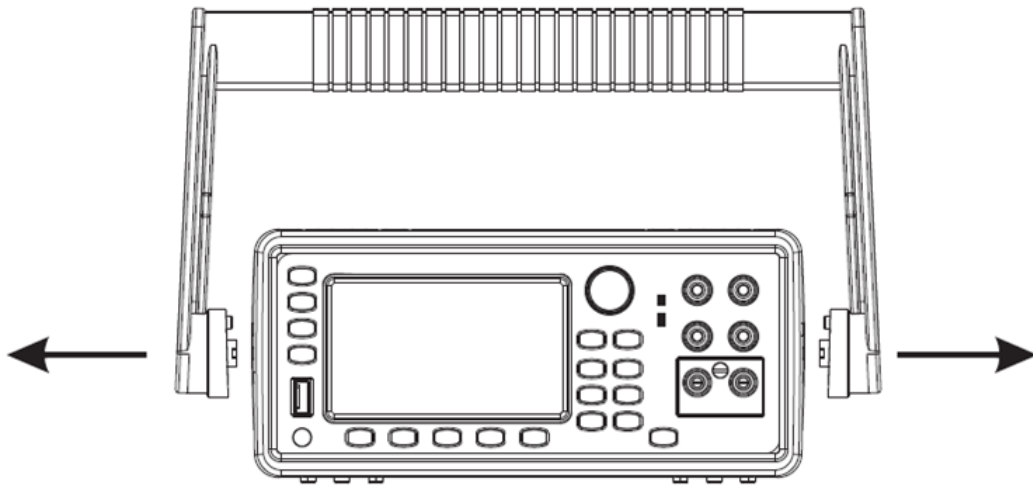When the handle is turned up to 90° with the DMM, please pull out the handle from the DMM as shown in **Figure 2-2**.

Figure 2-2

Ⅱ. Adjusting the position for your convenience

Here are some emple positions to for your reference.

【Position 1】

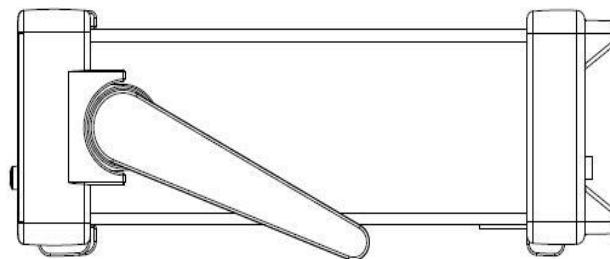The default position is for packing as shown as **Figure 2-3**.

Figure 2-3

【Position 2】

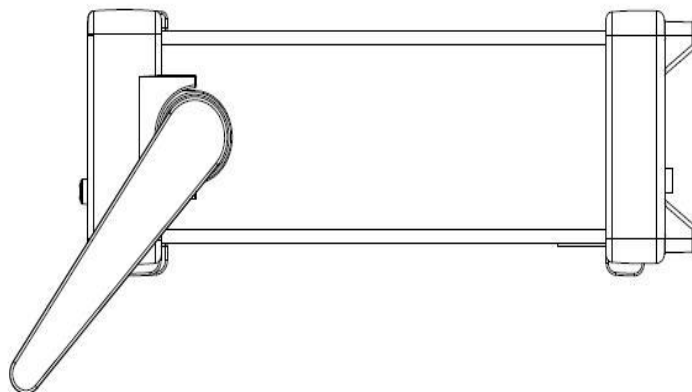The position shown as **Figure 2-4** is for operating the multimeter.

Figure 2-4

【Position 3】

The position shown as **Figure 2-5** is for carrying the multimeter.

Figure 2-5

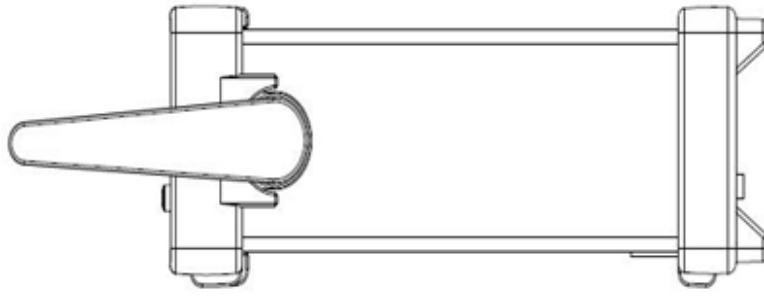## 2.1.2 To connect the power

M3530A is equipped with a Picotest-Exclusively-Designed switching power. So any incoming electric supplies within 100V to 240V are available to be used on this equipment. If your electric supply is unstable, you'd better connect a UPS between the electric supply and M3530A to prevent DMM from damage.

⚠ Warning! The power cord supplied with M3530A 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.

2.1.3 Factory Default When Power-ON

Table 2-1 shows the factory default of M3530A .

<div align="center">

Table 2-1

</div>

Function		Default
Location after Power On		DCV
Autozero		ON
Frequency and Period Source		AC Voltage
Output Format		ASCII
AC Voltage	Frequency	20Hz
	AC Digits	5.5
	Range	Auto
DC Voltage	DC digits	6.5 (1 PLC)
	Range	Auto
AC Current	Frequency	20 Hz
	AC Digits	5.5
	Range	Auto
DC Current	DC Digits	6.5 (1 PLC)
	Range	Auto
Frequency and Period	Digits	5.5
	Range	10 V
	Gate Time	100m Sec.
Ratio	Digits	6.5 (1 PLC)
	Range	Auto
	Input Impedance	10MΩ
Capacitance	Digits	4.5
	Range	Auto
Diode Test	Digits	5.5
	Range	1mA
	Rate	0.2 PLC
	Limit High	+800m
	Audible	Enable
Resistance (2-/4-wired)	Digits	6.5 (1 PLC)
	Range	Auto
Temperature	Digits	5.5 (1 PLC)
	RTD	RTD2W
Triggers	Source	Immediate
	Timer	00:00:00.100
	Delay state	Auto
	Out-Slope	Negative
	In-Slope	Negative
	Trigger Level	+0
	Sample Count	1
Input Resistance		10MΩ

2.2 M3530A Panel Introduction

For you to become familiar with the M3530A DMM, we will give a brief introduction to the basic operations. There are four major parts of M3530A: **(2.2.1) the front panel, (2.2.2) the display types, (2.2.3) the display, and (2.2.4) 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 as **Figure 2-6**. Here we divided the picture into 4 areas to describe.
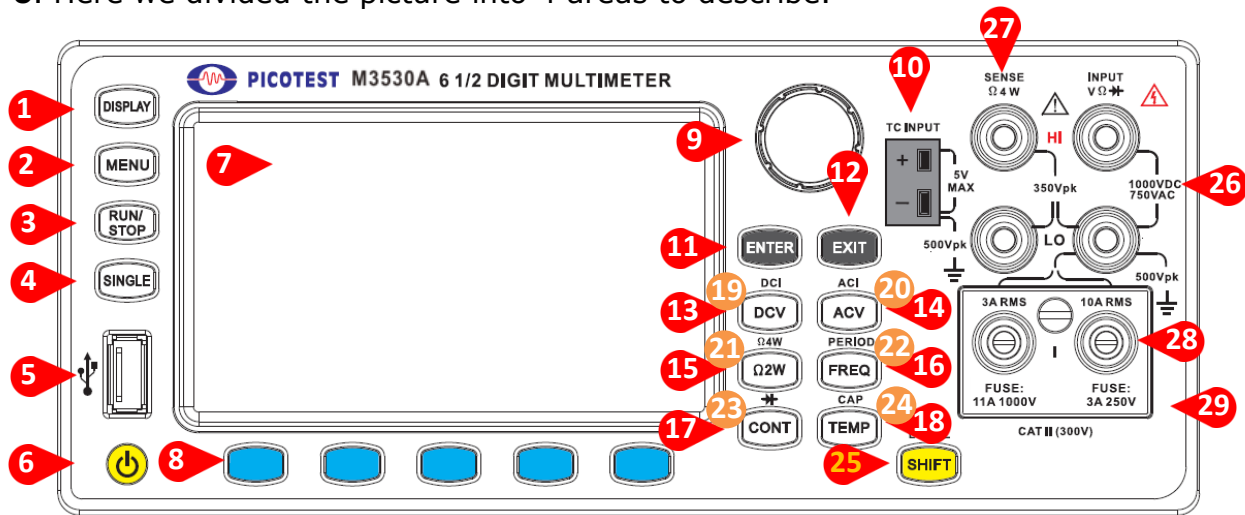

M3530A front panel
Figure 2-6

1. **DISPLAY:** Pressing the DISPLAY button each time, it will circularly and sequentially show the information of Chart, Histogram, and the main measurement screen. In addition, pressing the button for 3 seconds, the screen shot will be taken.
2. **MENU:** Pressing the MENU button, users can see the figures below to choose from according to their purposes to set measurement, trigger, or system. When one of the items is selected, the selected item will present in orange as shown below.

(i) Measurement:

(ii) Trigger:

(iii) System:
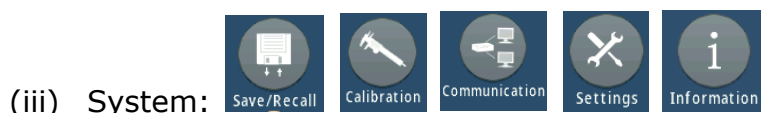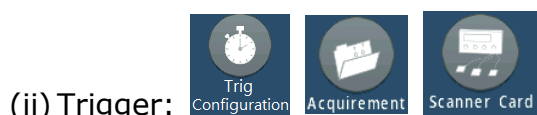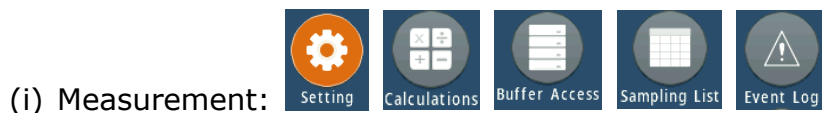
3. **USB host:** Plugging a USB sticker memory limited in FAT32.
4. **RUN/STOP:** Pressing RUN/STOP will continue or pause the present triggering.

5. **SINGLE:** Pressing the SINGLE button, the real-time measurement will be triggered once and stop and pressing it again will measure a new value then stop. After pressing RUN/STOP, M3530A will just keep running and triggering.

6. **Power:** Pressing the power button, the M3530A will be activated. Pressing it again, they will be shut down.

7. **Display:** It shows the measurement and setting results.

8. **Soft Key:** There are five blue soft keys at the bottom of the screen. Each button is correspondent to a condition setup. When switching to another function, the correspondent selection will be different. As for display contents, they will be presented at the section 2.2.2.

9. **Knob:** This knob possesses capacities of high sensitivity and precise toggle, i.e. Rotating and pressing it, the desired number and place will be reached.

10. **TC Input:** This input jack is a 2-pin-flat-mini-size TC connector for thermocouple measurement, and only allows users to insert this kind of plug including B, C, E, J, K, N, R, S, and T type. Here a K type at right side is provided as an emple. The terminals of M3530A come with the built-in cold junction compensation. So no extra thermocouple adapter is needed. This function is only for M3530A.

11. **ENTER:** Pressing the ENTER button is to accept users' selection, and move to next choice or back to measurement display.

12. **EXIT:** Pressing the EXIT button is to cancel the selection, move back to the upper layer, or toggle to the measurement display.

13. **DCV:** Pressing the DC button once, users can measure DC voltage.

14. **ACV:** Pressing the ACV button once, users can measure AC voltage.

15. **Ω2W:** Pressing the Ω2W button, users can measure 2-wire resistance.

16. **FREQ:** Pressing the FREQ button, users can measure frequency.

17. **CONT:** Pressing the CONT button, users can measure continuity.

18. **TEMP:** Pressing the TEMP button, users can measure RTD and TC temperature.

19. **DCI:** Pressing the DCV and SHIFT buttons, users can measure DC current.

20. **ACI:** Pressing the ACV and SHIFT buttons, users can measure AC current.

21. **Ω4W:** Pressing the Ω2W and SHIFT buttons, users can measure 4-wire resistance.

22. **PERIOD:** Pressing the FREQ and SHIFT buttons, users can measure period.

23. **⇥⊢:** Pressing the CONT and SHIFT buttons, users can measure diode.

24. **CAP:** Pressing the TEMP and SHIFT buttons, users can measure capacitance.

25. **SHIFT:** The SHIFT button is used with DCV, ACV, Ω2W, FREQ, CONT, and TEMP to toggle to functions of DCI, ACI, Ω4W, PERIOD, ⇥⊢, and CAP respectively.

26. **INPUT HI & LO:** The input HI and LO are used for all measurements, except DC/AC current. (Maximum input voltage: 1000V for voltage measurements. 200V for 4-wire measurement)

27. **SENSE HI & LO:** The sense HI and LO are used for 4-Wire resistance measurement (Maximum input voltage: 200V for 4-wire measurement)
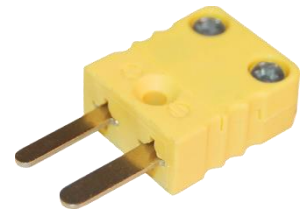
※ Note: It's important to know that when executing the multi-channel measurement

28. **INPUT LO & I:** The input LO and I are used for making DC/AC current measurement.
29. **Fuse Cabin:** There are two fuses behind the 10A and 3A input terminals, located at the fuse cabin, and used to prevent your meter against damage of strong current pulse. (Fuse Spec: 11A, 1000V at 1 terminal. 3A, 250V at 3A terminal)

2.2.2 Overview of the Display States

The following emples via pressing DISPLAY or MENU buttons can show the display states such as big numbers, chart, histogram, dual display, triple DCV, menu setup, multi-language selection, date & time setup, backlight adjustment, backlight saver, and screen shot.

1. **Display State with Big Numbers**

    The big number display state under DCV measurement is the factory default when powering on for the first time. Of course, you can start it up with your self-defined measurement and setup.

2. **Chart State**

    This chart state shows the real-time measured readings cumulated until the function is changed.
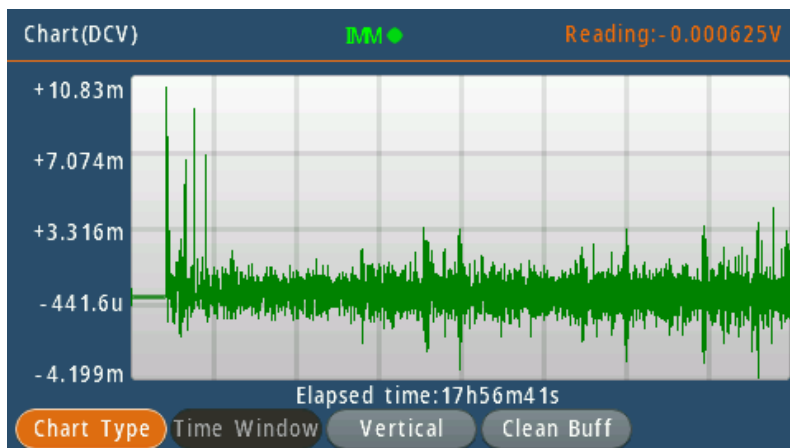
3. Histogram State
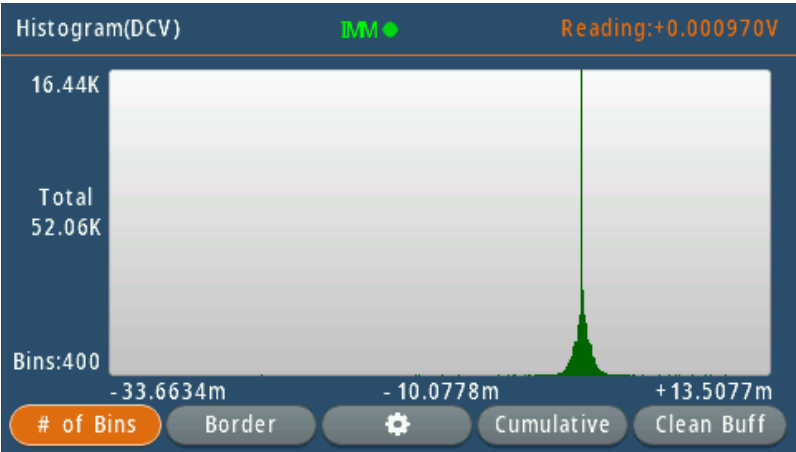
4. Dual Display State
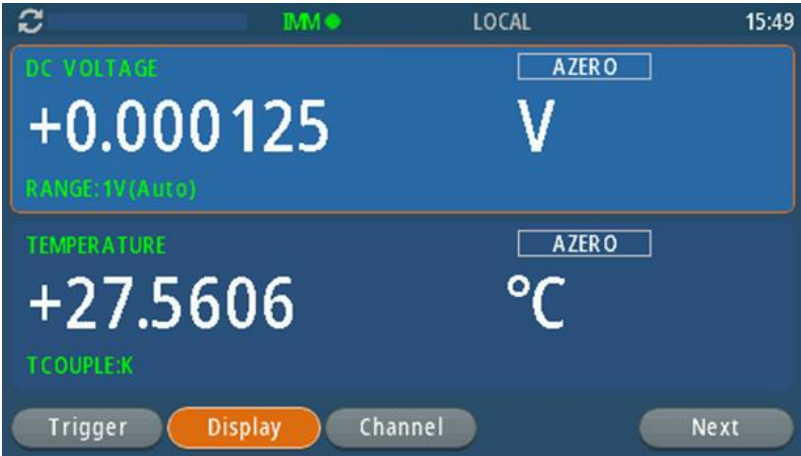
5. Multi-Channel Display State

6. Menu Setup State
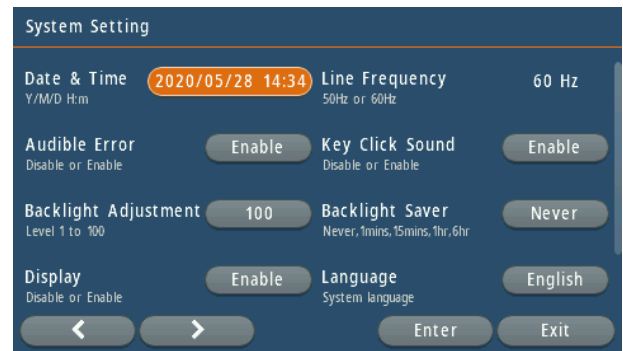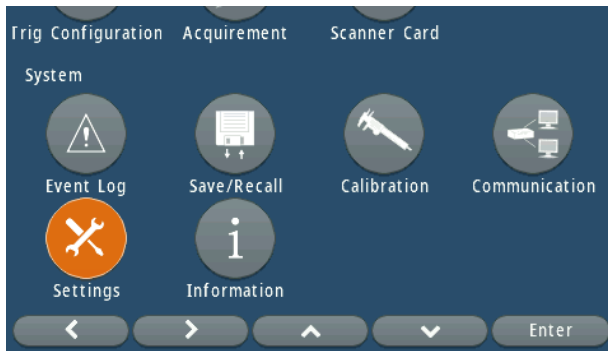
7. Multi-Language Selection State
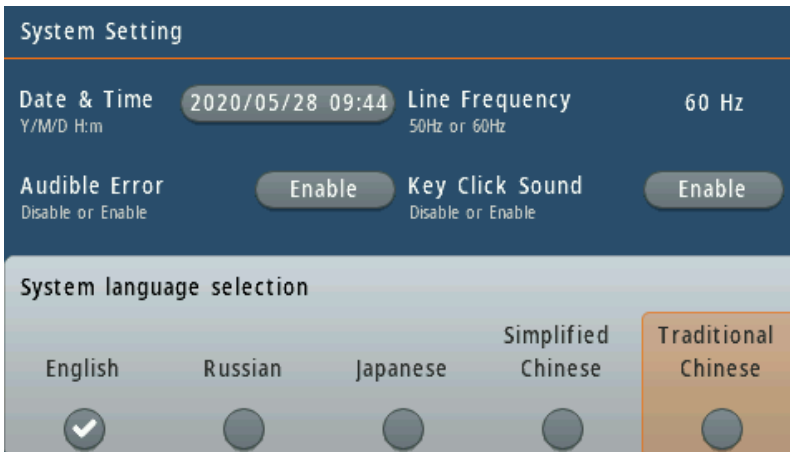
8. Date & Time Setup State
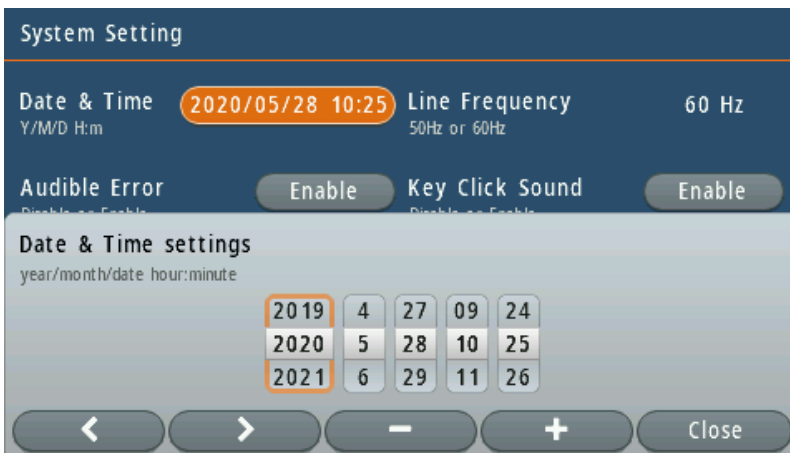
9. Backlight Adjustment State
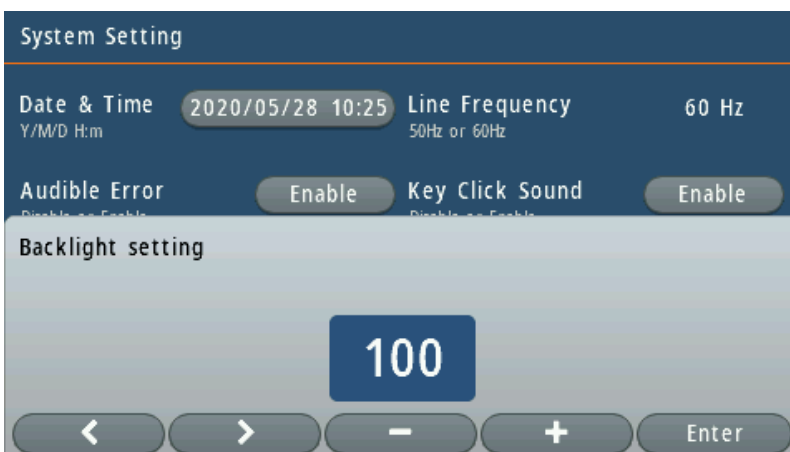
10. Backlight Saver State
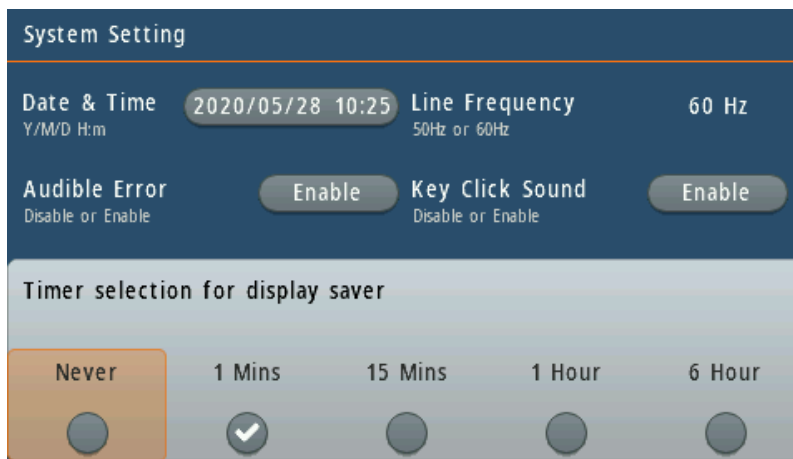
11. Screen Shot State

This function has to work with a USB stick memory in FAT32 format. Without it, the screen shot is not able to be used. When the USB device is plugged, the screen will show "The USB drive detected" as shown below.

Pressing the DISPLAY button on the front panel for 3 seconds, the screen shot will be applied, and show "File – Saving finished. Press any key to skip the reminder" as shown below.

2.2.3 The Display

M3530A has a 4.3" color TFT (9.5 x 5.3 cm) with LED backlight. The display can present in big numeric, showing the second display for other function use, or get into a graphical mode. There are three rows on the display as shown as **Figure 2-7**. The upper row displays the measuring state and time. The middle row (Main Measurement) displays the measured value including the conditions of showing function, unit, range, autozero, and real-time statistic. The bottom row (Condition Setup) displays the relative setup which allows users to set, and can affect the measured result. For more detailed descriptions, they are shown individually in the following sections.
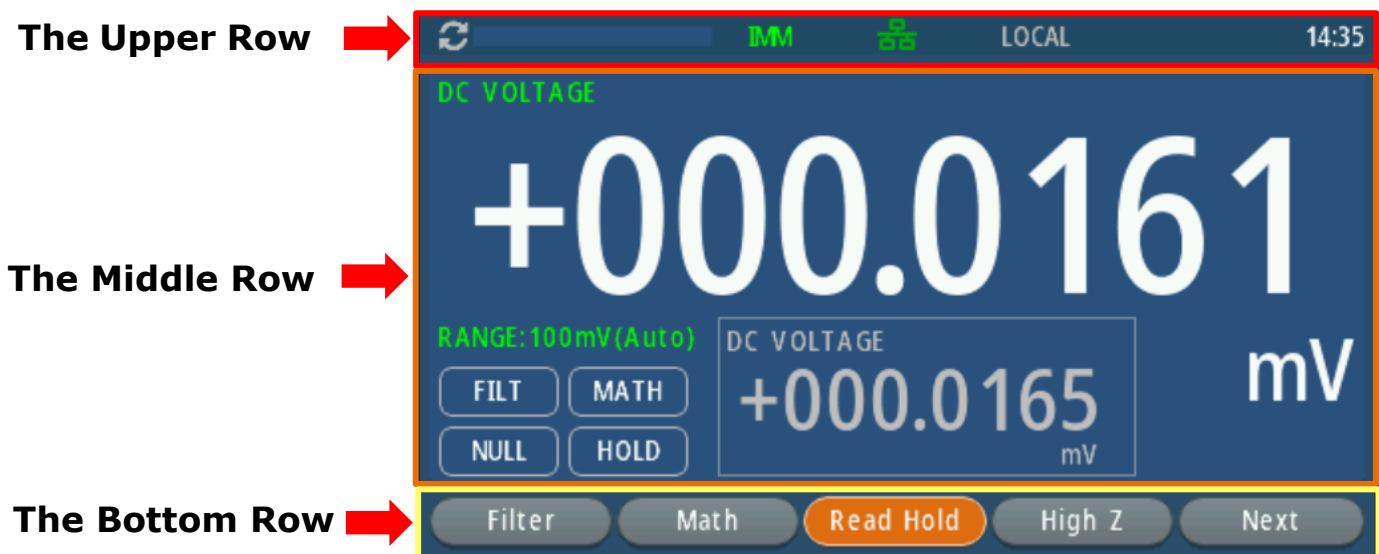
Figure 2-7

2.2.3.1 The Upper Row (Annunciators)

- : It indicates the buffer's state showing empty.

- **IMM◆**: It indicates the state of immediate measuring, which goes with a flashing green point. When pressing stop button, it will stop triggering, and show "IMM STOP". The triggering mode will be changed to "EXT", "TIME", "MAN", or "INT" according to your setup.

- : It indicateds the remote communication via LAN is enabled and connected.

- **LOCAL:** It indicates the present operation is through the front panel. If it shows RMT, the operation is through the remote control of USB, LAN, RS-232, or GPIB.

- **14:35:** It indicates the present time and can be adjusted through the system setup.

2.2.3.2 The Middle Row (Main Measurement)

- **DC VOLTAGE:** It indicates the function of DCV.
- **+000.0161:** It shows the FILT/NULL/MATH value after activating the HOLD function.
- **mV:** It indicates the unit of the measurement.
- **10MΩ:** It indicates impedance information.
- **FILT/MATH/NULL/HOLD:** This indicates that the filter, the math, the null, and the hold functions are enabled.
- **100mV (Auto):** It indicates the DCV auto-range 100mV is adopted.
- **DC VOLTAGE +000.0165mV:** It indicates the present measured value.

2.2.3.3 The Bottom Row (Condition Setup)
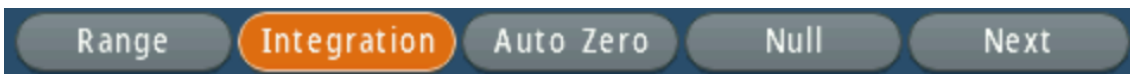
Please note that different measurement functions have different bottom row allocation. Users can set conditions according to their applications. For detailed setup, the function sections will give more introductions. Take a look at the following **List 1** which shows the available setup items under the specific function.

No.	Func-tion	List 1 - **Available Setup Items**
1.	DCV	Range, Integration, Auto Zero, Null, Filter, Math, Read Hold, High Z, Trigger, Display
2.	DCI	Range, Integration, Auto Zero, Null, Filter, Math, Read Hold, Trigger, Display
3.	ACV	Range, Bandwidth, Null, Filter, Math, Read Hold, Trigger, Display
4.	ACI	Range, Bandwidth, Null, Filter, Math, Read Hold, Trigger, Display
5.	Ω2W	Range, Integration, Auto Zero, Null, Filter, Math, Read Hold, Trigger, Display
6.	Ω4W	Range, Integration, Null, Filter, Math, Read Hold, Trigger, Display
7.	FREQ	Measure, Range, Aperture, Bandwidth, Null, Filter, Math, Read Hold, Trigger, Display
8.	RATIO	Range, Integration, Null, Filter, Math, Read Hold, High Z, Trigger, Display
9.	CONT	Threshold, Audible, Trigger, Display
10.	DIOD	Bias Level, Audible, Trigger, Display
11.	TEMP	Transducer, Type, Integration, Null, Filter, Math, Read Hold, Auto Zero, Trigger, Display
12.	CAP	Range, Null, Filter, Read Hold, Trigger, Display

2.2.4 The Rear Panel

The rear panel of the M3530A is shown as **Figure 2-8**. This figure includes important abbreviated information that should be reviewed before using the instrument.
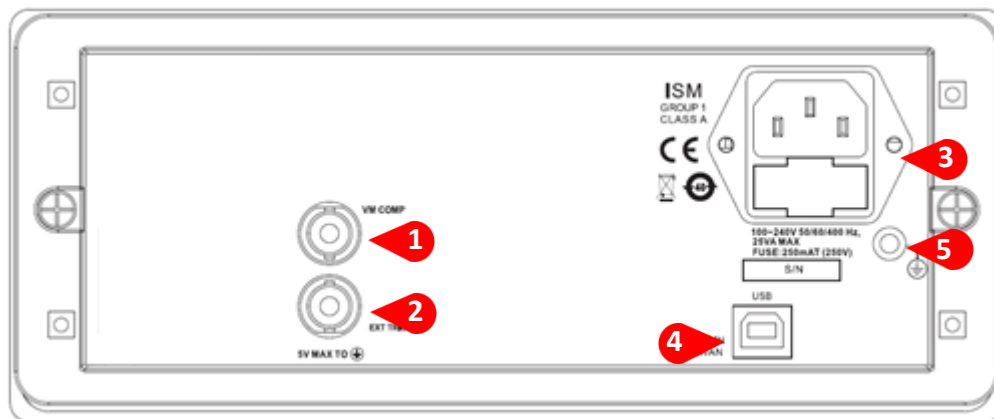
Rear Panel

Figure 2-8

- **VM COMP:** Voltmeter Complete Output Terminal. Outputs a low-true pulse to a remote interface. M3530A also provides the VM COMP.
- **EXT TRIG:** Terminal to be used when choosing external triggering. M3530A also provides the EXT TRIG.
- **Power Input:** This module includes the AC line receptacle, and power line fuse, and also supports 100V to 240V input AC power.
- **USB Connection (USBTMC):** Connects a remote computer for changing operation environment instead of the front panel control.
- **Chassis Ground**: Generally, this screw is fastened with a wire connected to the Earth. This connection can prevent electronic shock from external input, and protect your device under test from damage.

2.3 Fuse Replacement at 3A and 10A Terminals

There are a few procedures teaching users to replace the broken fuse on the front or rear panel. (Fuse Spec: 11A, 1000V at 10A terminal. 3A, 250V at 3A terminal) On the other hand, the M3530A doesn't support the rear terminals.

1. Use a slotted screw driver to release the screw.
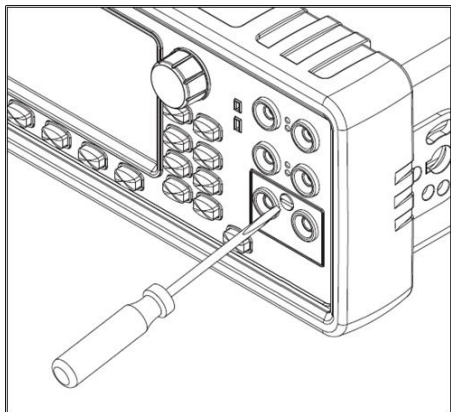
2. Pull out the screw and drag away the fuse cabin.
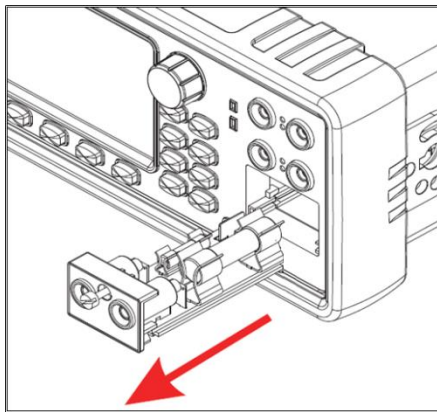
3. Replace the broken 3A fuse from the pedestal.
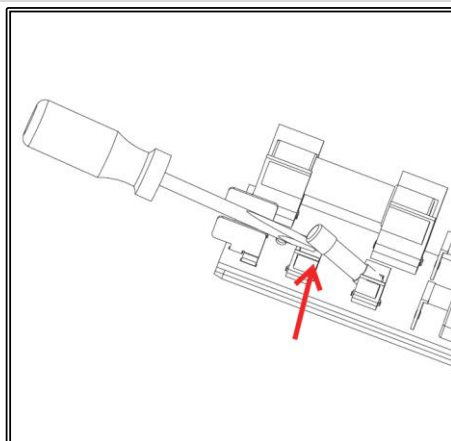
4. Replace the broken 1 fuse from the pedestal.
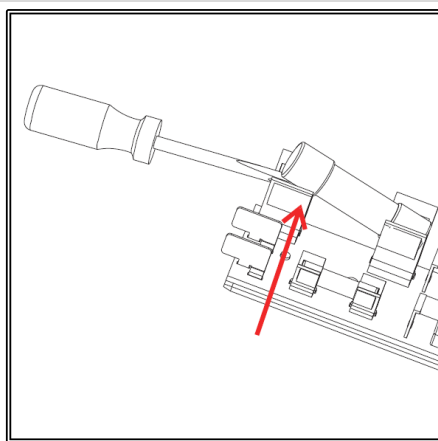
When the replacement is done, install the cabin back, and fasten the screw.

2.4 Fuse Replacement at Power Input

There is a fuse in the power module on the rear panel. It can be equipped at your place, but requires a qualified engineer to do this. Replacing this fuse, please refer to the following procedures.

1. Use a slotted screw driver for this replacement.
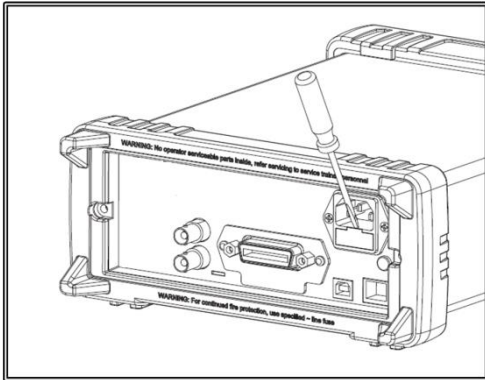
2. Separate the power fuse socket from the AC power module.
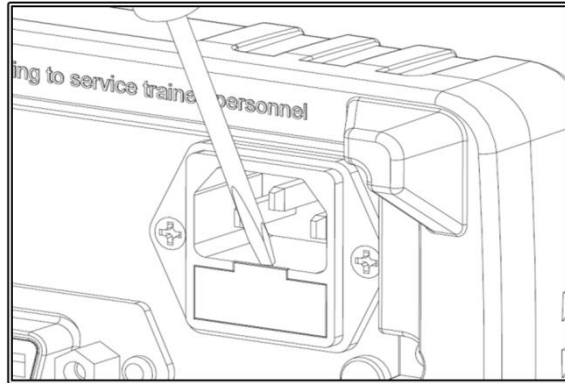
3. When separating the socket, the power fuse will be found.
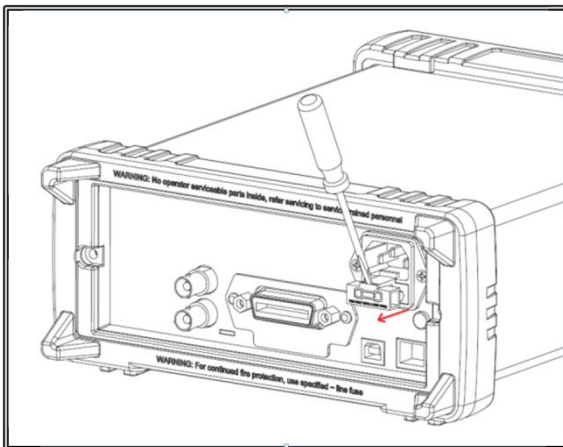
4. Replace the malfunctioned fuse with a new. Reverse the above procedures, and check whether it can work properly.
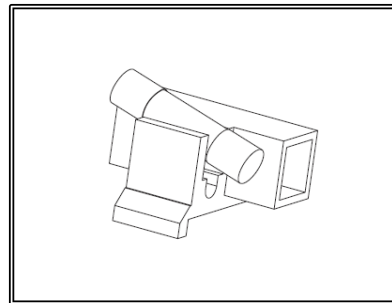
2.5 GPIB Card/RS-232 Card Assembly

This card is provided only for M3530A. It can be equipped at your place, but requires a qualified engineer to do this. Installing this accessory, please refer to the following procedures.

1. Prepare a GPIB/RS-232 card, and connect the attached bus cable.
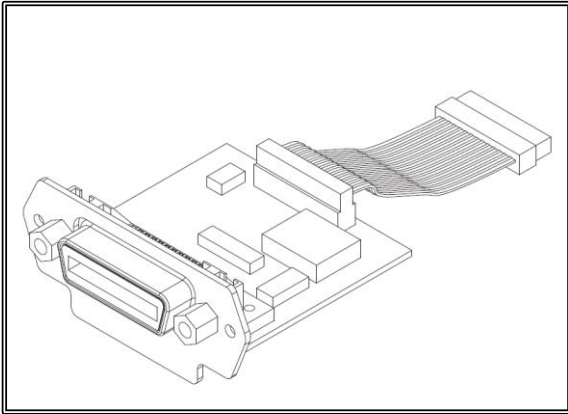
2. Plug the cable into the bus jack.
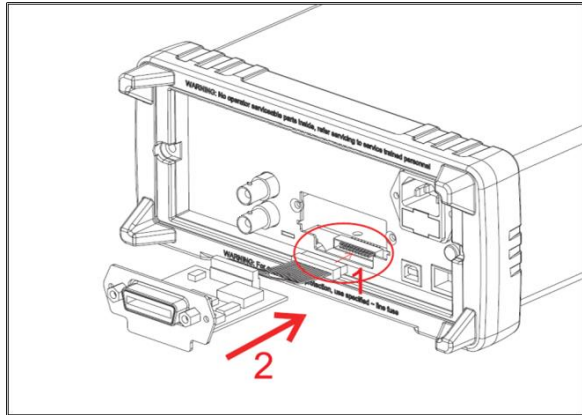
3. Make sure each pin is straight.
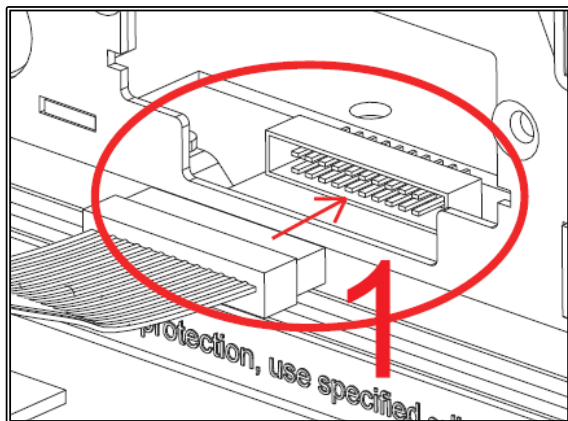
4. Fasten the card on the DMM.
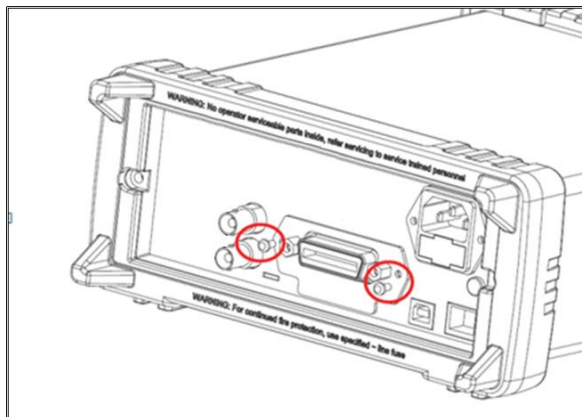
3 Basic Measurement Function

This chapter introduces some basic measurement functions on M3530A . You will learn how to use it to measure voltage, current, resistance, frequency, period, continuity, diode and temperature in this chapter. Users are allowed to set M3530A via three kinds of methods below.

1. **Setup via the Soft-Keys:** The common-used configurations at the bottom of the display, of which are correspond to the soft-keys, provide users the overall and convenient setup.

2. **Setup via a Function Button:** The measurement setup will be accessed by pressing a desire function button for 2 seconds. Some functions have to be conducted via the SHIFT button, such as DCI, ACI, Ω4W, RATIO, DIODE, and CAP.

3. **Setup via the MENU Button:** When needing the full setup on each function, users have to select a desire function first (Some functions have to be conducted via the SHIFT button, such as DCI, ACI, Ω4W, RATIO, DIODE, and CAP.), and press the MENU button to enter.

3.1 Voltage Measurement (DC & AC)

The ranges for DC voltage measurement on M3530A are 100mV, 1V, 10V, 100V and 1000V. For AC voltage measurement, the ranges are 100mV to 750V AC-Coupled TRMS, or 1000V peak. **Figures 3-1** and **3-2** show the locations of the buttons needed and message display for voltage measurement.

⚠ 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. Select an input signal connection on the front M3530A.

2. Connect the test leads to the terminals as shown as **Figure 3-1**(DCV Input Measurement) or **Figure 3-2** (ACV Input Measurement).

   ※ Note: When executing the multi-channel measurement on DCV, the measurements are able to be made via the following connections, for emple INPUT HI up to 1000V, SENSE HI up to 12V, and SENSE LO up to 12V. Their grounds must be connected to INPUT LO as shown as **Figure 3-3**. Any out-of-spec input voltage might cause the DMM malfunctioned.

3. Set Display Digits of DCV (Refer to 4.1.3), Bandwidth of ACV (Refer to 4.1.2.1) or skip this step if default is to be used.

4. Press DCV or ACV button for DC or AC voltage measurement respectively.

5. Set DC voltage, such as the Range, Integration, Auto Zero, Null, Filter, Math, Read Hold, High Z, Trigger, or Display using the soft-key. If measuring AC voltage, you might need to set Range, Bandwidth, Null, Filter, Math, Read Hold, Trigger, or Display using the soft-key. Or leave it/them with the default. Of course, users also can use the other two ways of pressing a desire function button in two seconds for measurement setup, or MENU button for full function setup.

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

Input Resistance = 10MΩ on 1000V and 100V ranges

Input Resistance > 10GΩ on 10V, 1V and 100mV ranges
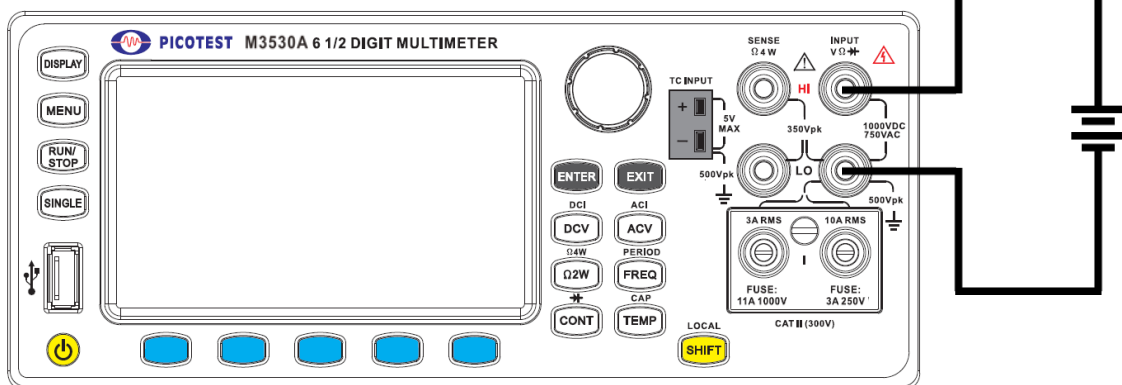
DCV Input Measurement

Figure 3-1

Input Impedance = 1MΩ in parallel with < 100pF
(Warning: Maximum Input = 750V VAC, 1100V peak)
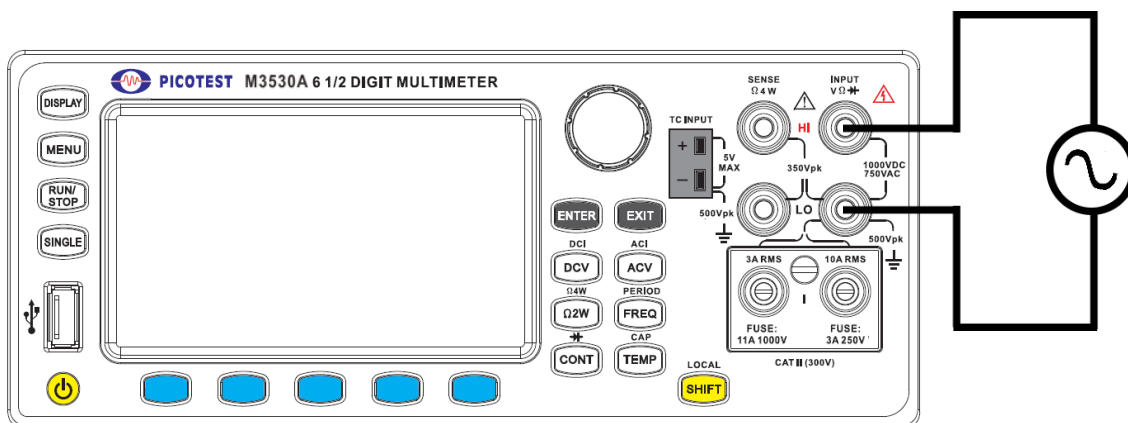
ACV Input Measurement

Figure 3-2

When you need the multi-connections, reach the path **Display** > **Multi-Channel** using the soft-key or the knob. The display will be switched to triple DCV measurement as **Figure 3-3**, and **3-4** shown.

Path: Display > Multi-Channel	Triple DCV Measurement Activated
Figure 3-3	**Figure 3-4**

※ Note: This triple measurement is provided only on DCV function of M3530A.

3.2 Current Measurement (DC & AC)

The ranges for DC current measurement in M3530A are 100uA~ 10A. For AC current measurements, the range is 100uA~ 10A. **Figure 3-6** and **3-7** show you how to measure DC/AC current at 3A and 10A respectively.

⚠ Warning! Using over 10A input application at 3A terminal will burn out the internal fuse. Do not apply excess current to your meter to avoid damaging the fuse of current input.

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

How to measure current

1. Select an input signal connection on the front panel of M3530A.
2. Connect the test leads to the terminals as shown as **Figure 3-6, 3-7, and 3-8**.
3. Set Display Digits of DCI (Refer to 4.1.3), Bandwidth of ACI (Refer to 4.1.2.1) or skip this step if default is to be used.
4. Press SHIFT, DCV or SHIFT, ACV buttons in order for DCI or ACI measurement.
5. Set DC current, such as the Range, Integration, Auto Zero, Null, Filter, Math, Read Hold, Trigger, or Display using the soft-key. If measuring AC current, you might need to set Range, Bandwidth, Null, Filter, Math, Read Hold, Trigger, or Display using the soft-key. Or leave it/them with the default. Of course, users also can use the other two ways of pressing a desire function button in two seconds for measurement setup, or MENU button for full function setup.
6. Connect test leads to your source end, and observe the reading shown on the display. If the input signal is greater than the allowed range, an overflow message "OVLD" will

be displayed.

The following **Figure 3-6** shows the connection of 100μA, 1mA, 10mA, 100mA, 1A, and 3A range measurement.
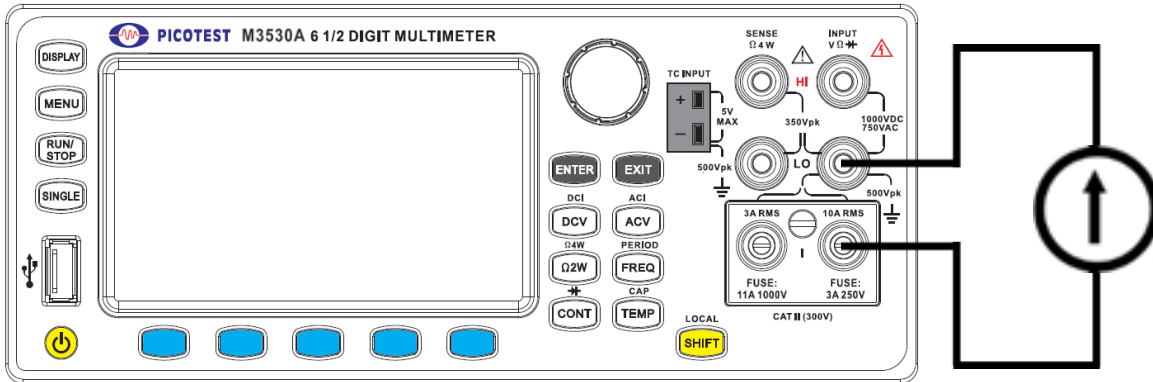
3A Range Measurement
Figure 3-6

The following **Figure 3-7** shows the connection of 10A range measurement.
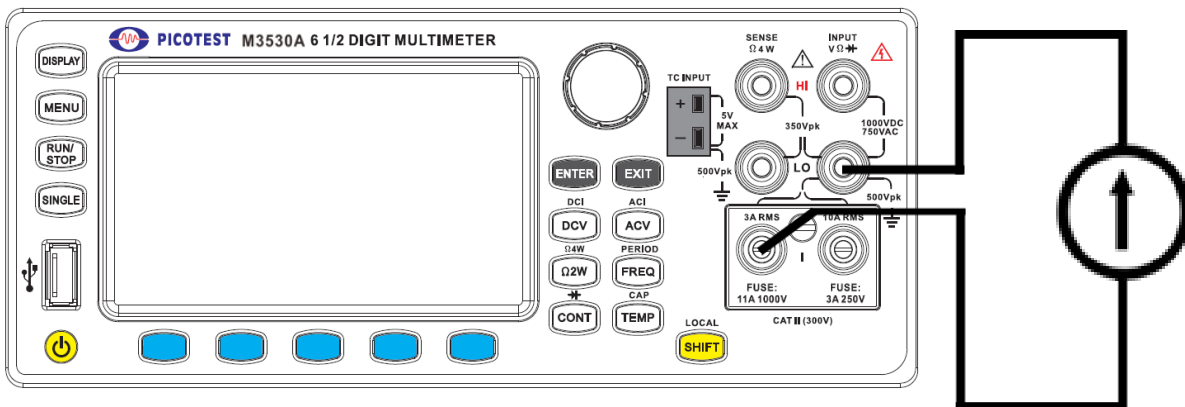
10A Range Measurement
Figure 3-7

3.3 Resistance Measurement (2 & 4-wire)

The ranges for resistance measurement are 100 Ω, 1KΩ, 10kΩ, 100kΩ, 1MΩ, 10MΩ, and 100MΩ, with the sensitivity of 100 μΩ (on 100 Ω range.) There are two modes for measuring the resistance: 2-wire mode as shown as **Figure 3-9** and 4-wire mode as shown as **Figure 3-10**. 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. Select an input signal connection on the front panel of M3530A.

2. Connect the test leads to the terminals as shown as **Figure 3-9** (2-wire) or **Figure 3-10** (4-wire).
3. Set RESOLUTION (Refer to 4.1.3) or skip this step if the default is used.
4. Press Ω2W button for 2-wire measurement or SHIFT + Ω2W buttons for 4-wire measurement.
5. Set the range, Integration, Auto Zero, Null, Filter, Math, Read Hold, Trigger, or Display using the soft-key. Or leave it/them with the default. Of course, users also can use the other two ways of pressing a desire function button in two seconds for measurement setup, or MENU button for full function setup.
6. Connect test leads to your source signal and observe the reading shown on the display. If the input signal is greater than the allowed range, an overflow message "OVLD" will be displayed.
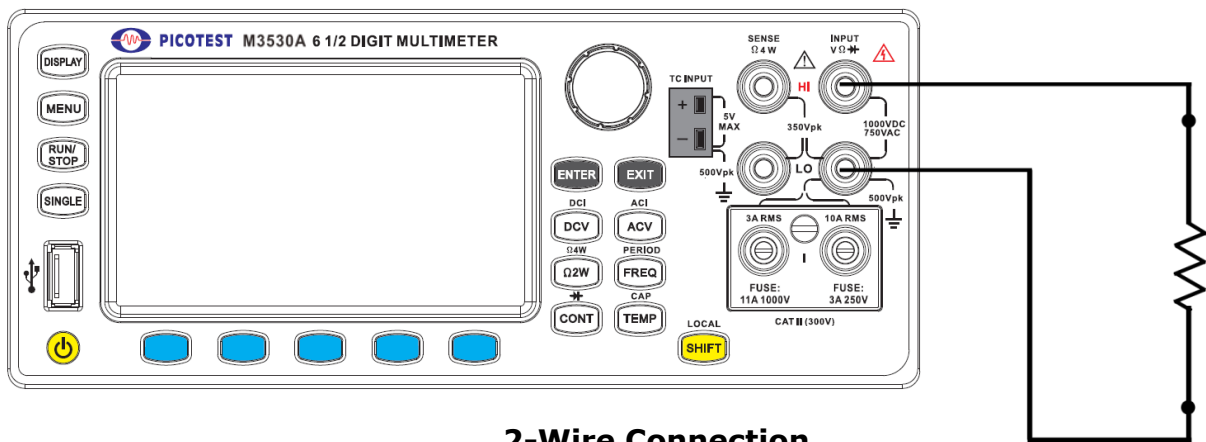
2-Wire Connection

Figure 3-9

※ Note: Source current flows from the INPUT HI to INPUT LO terminals.
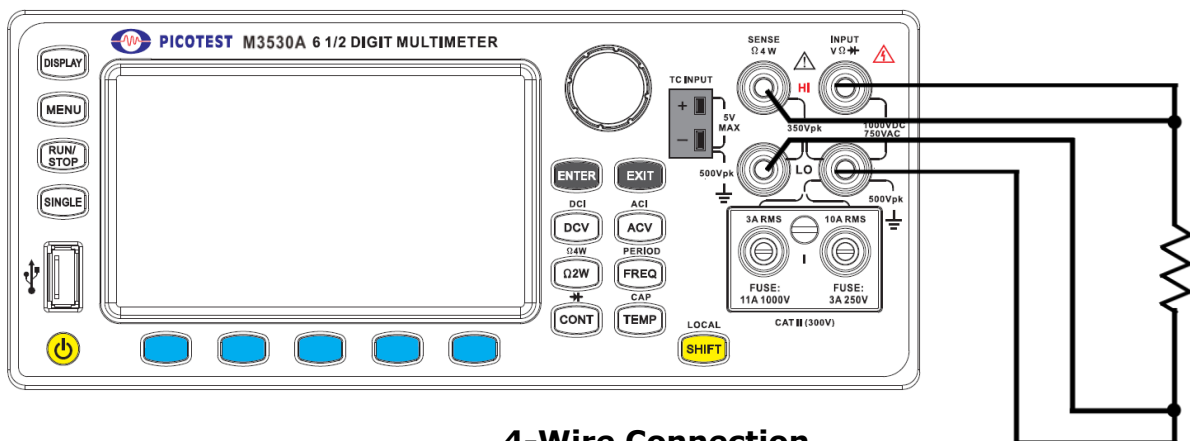
4-Wire Connection

Figure 3-10

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

3.4 Frequency & Period Measurement

M3530A   use an on-board counter with 25MHz to measure the frequency (period). The measurement band is from 10Hz to 300kHz (or 100 ms to 3.3 µs) and the measurement voltages range from 100mV to 750 V in AC. The default for "RANGE" is auto-range.

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

How to measure frequency and period

1. Select an input signal connection on front panel of M3530A.
2. Connect the test leads to the terminals as shown as **Figure 3-11**.
3. Set RESOLUTION (Refer to 4.1.1) and INPUT JACK. Or skip this step if using the default.
4. Press FREQ button for frequency measurement or press the Measure soft-key for period measurement.
5. Set the Range, Aperture, Bandwidth, Null, Filter, Math, Read Hold, Trigger, or Display using the soft-key. Or leave it/them with the default. Of course, users also can use the other two ways of pressing a desire function button in two seconds for measurement setup, or MENU button for full function setup.
6. Connect test leads to your source signal and observe the reading shown on the display. If the input signal is beyond the allowed range, an overflow message "OVLD" will be displayed.

Input Impedance = 1MΩ in parallel with < 100pF
(Warning: Maximum Input = 750V VAC, 1100V peak)
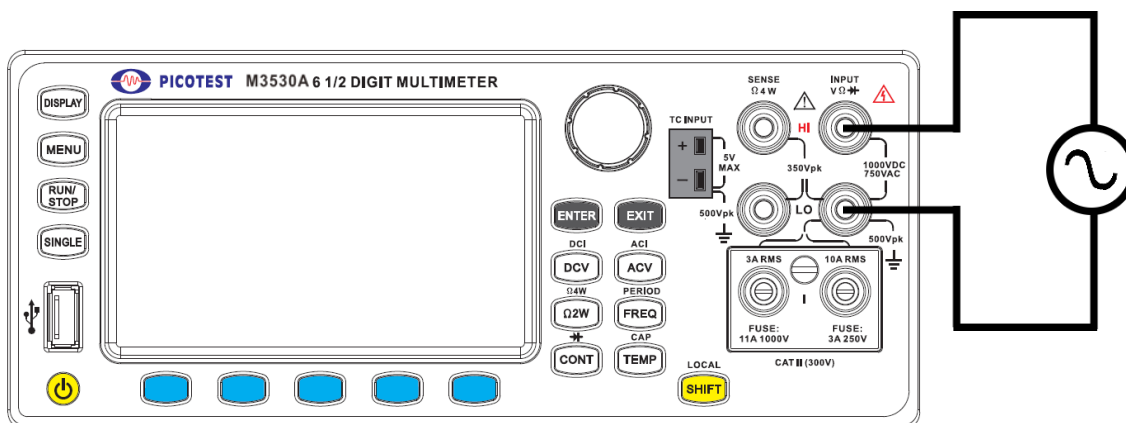
Frequency & Period Measurement
Figure 3-11

3.5 Ratio Measurement

This ratio measurement gives the result of an input DC voltage to a reference DC voltage according to the following equation:

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

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

1. Ratio Measurement through the Front Panel Operation
- Operate through the front terminals.
- Follow the DCV connection as shown as **Figure 3-1**.
- Press SHIFT+FREQ buttons to access the RATIO measurement.
- Set "Resolution Setup" (Refer to 4.1.3), and "Digital Filter" (Refer to 4.1.2.2).

※ Note1: To close this function, please press one of the measurement function buttons.

※ Note2: The maximum DC input voltage protection is 1000V, and 200V for the reference voltage.

※ Note3: At the Sense terminals, dc voltage is always there while using the reference voltage measurement function which has a maximum measurable input of ± 12Vdc.

※ Note4: The Input LO and Sense LO terminals, having a common reference, can't have a voltage difference greater than ± 0.2 volts.

※ Note5: The specified measurement range is used only for the signal connected to the Input terminals. And the signal on the Input terminal can be any dc voltage up to 1000 V.

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

3.5.1 Ratio +

Ratio + is an application which requires to activate the (Ratio +) function on DCV. The equation showing below is similar to the Ratio measurement.

$$Ratio\ + \ = \frac{DC\ Input\ \ Voltage}{DCV\ Input\ (Sense\ HI\ -\ Sense\ LO)}$$

1. Ratio + Measurement through the Front Panel Operation
- Operate through the front terminals
- Follow the DCV connection as shown as **Figure 3-1**.
- Made the other two connections through SENSE HI with 12V at most, and SENSE LO with 12V at most. Their grounds must be connected to INPUT LO.
- Press SHIFT+FREQ buttons to access the RATIO measurement.
- Execute the (Ratio +) referring to the **Figure 3-3.**
- Change values of numerator or denominator through Ratio + configuration if needed.

3.6 Continuity Measurement

M3530A   use 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. Select an input signal connection on the front panel of M3530A.
2. Connect the test leads to the INPUT HI and LO with a resistor (DUT) as shown as **Figure 3-12**.
3. Press the CONT button.
4. Set Threshold, or Audible using soft-keys. Or leave it/them with the default. Of course, users also can use the other two ways of pressing a desire function button in two seconds for measurement setup, or MENU button for full function setup.
5. The measured value will be shown on the display automatically. And your DMM will "beep" when the measured resistance value is lower than threshold value.
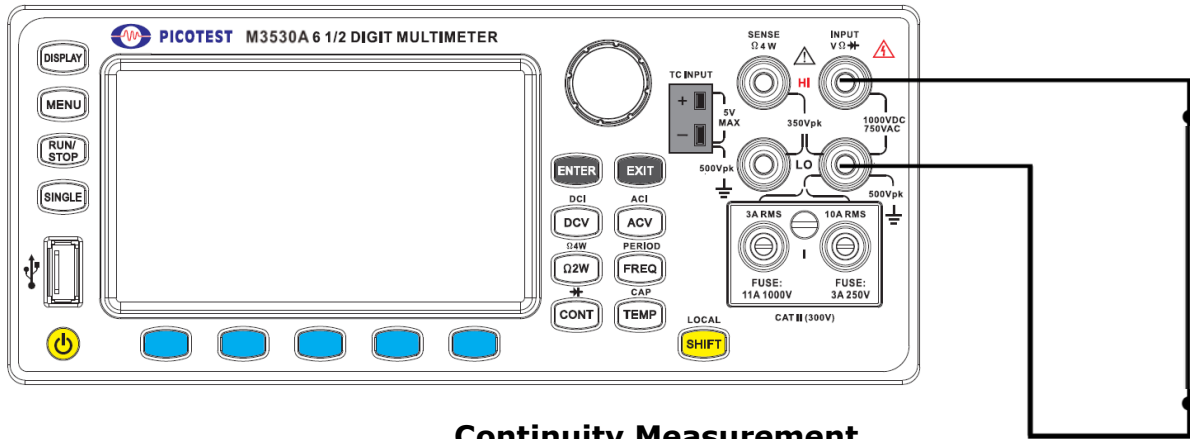
Continuity Measurement

Figure 3-12

(※ Note: Source current flows from the INPUT HI to INPUT LO terminals.)

3.7 Diode Measurement

M3530A can be selected a current source from 1μA, 10μA, 100μA, 1 mA for diode testing. The maximum resolution is fixed at the range of 10 V DC. The default threshold voltage is fixed between 0.3 and 0.8 volts and the reading rate is fixed at 0.1 PLC. A "Beep" sound will appear when the diode measured value is in the range.

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

How to measure diode

- Select an input signal connection on the front panel of M3530A.
- Connect the diode to the INPUT HI & LO. For forward bias, connect the probe from input terminal "HI" to the positive end of the diode, and the probe from input terminal "LO" to the negative end of the diode as shown as **Figure 3-13**.
- Set Bias Leve, or Audible using the soft-keys. Or leave it/them with the default. Of course, users also can use the other two ways of pressing a desire function button in two seconds for measurement setup, or MENU button for full function setup.
- Press SHIFT + CONT buttons to start using the diode function, and observe the reading on the display.
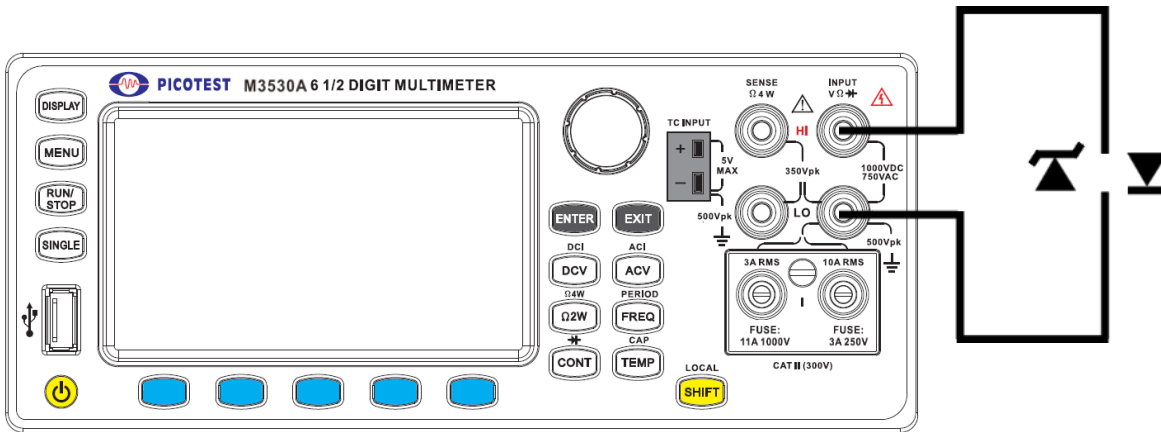
Diode Measurement

Figure 3-13

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

3.8 Temperature Measurement

The M3530A supports resistance temperature detector (RTD), thermistor-based, and thermocouple temperature measurement (TCO).

The M3530A provides thermistor measurement. For thermocouples measurement, M3530A supports 9 types: B, C, E, J, K, N, R, S and T. Ensure that the temperature function is configured for the right sensor type before measuring (Refer to 4.1.8 for how to make the sensor configuration).

In general, RTDs have a better accuracy and long-term stability than thermocouples. The default TCO in M3530A is type K, the default RTD is PT100 (Temperature Range: -200~850), and the default thermistor is 5KΩ.

The follows show the different temperature models with their own type figures.

1. Thermocouple (with a cold junction inside): Type in B, C, E, J, K, N, R, S, or T. See **Table 3-2**
2. RTD (RTD2W/RTD3W/RTD4W): Type in PT100, D100, F100, PT385, PT3916, RTD_USER, or SPRTD
3. Thermistor (Therm2W/Therm4W): Type in 2252Ω, 5KΩ, 10KΩ, or NTC_USER

Table 3-2

(Temperature Ranges for Each Thermocouple Type)

Sensor Type	Temperature Range(°C)
B	600~1820
C	0~2316
E	-250~1000
J	-210~1200
K	-200~1372
N	-200~1300
R	0~1767
S	0~1767
T	-250~400

3.8.1 Thermocouple (TCO) Measurement

This TCO with the build-in cold junction allows users to directly sense temperature without a complicated setup. In addition, the TCO measurement can be used on M3530A only.

How to measure with thermocouple

- Plug a thermocouple sensor such as Type B, C, E, J, K, N, R, S, or T to the TC INPUT jack.
- Press the TEMP > MENU > Measurement Setting.
- Set Transducer to TCO, Thermocouple to K type, Reference Junction to Real. The other parameters can be set according to your application requirement.
- Press the Exit button twice to start measuring.

3.8.2 RTD Measurement

The RTD principle shows a platinum resistance temperature detector (RTD in abbreviation) is a device with a typical resistance of 100 Ω at 0 °C. It consists of a thin film of platinum on a plastic film. Its resistance varies with temperature and it can typically measure temperatures up to 850 °C. Passing current through an RTD generates a voltage across the RTD. By measuring this voltage, you can determine its resistance and, thus, its temperature. The relationship between resistance and temperature is relatively linear.

RTDs are commonly categorized by their nominal resistance at 0 °C. Typical nominal resistance values for platinum thin-film RTDs include 100 and 1000 Ω. The relationship between resistance and temperature is nearly linear and follows this equation:

For <0 °C RT = R0 [1 + aT + bT2 + cT3 (T - 100)] (Equation 1)

For >0 °C RT = R0 [1 + aT + bT2]

Where RT = resistance at temperature T / R0 = nominal resistance / a, b, and c = constants used to scale the RTD

The resistance/temperature curve for a 100Ω platinum RTD, commonly referred to as Pt100, is shown in Figure 2.

There are three kinds of RTD measurements in 2 wiring, 3 wiring, and 4 wiring. You will find the connection instructions and measuring procedures in the following sections.

3.8.2.1 RTD Measurement in 2 Wiring

From the above RTD principle, let's get to see the RTD measurement in 2 wiring with M3530A . The following pictures are the RTD diagram, and the RTD adapter connected with the front panel of M3530A .

1. RTD Diagram
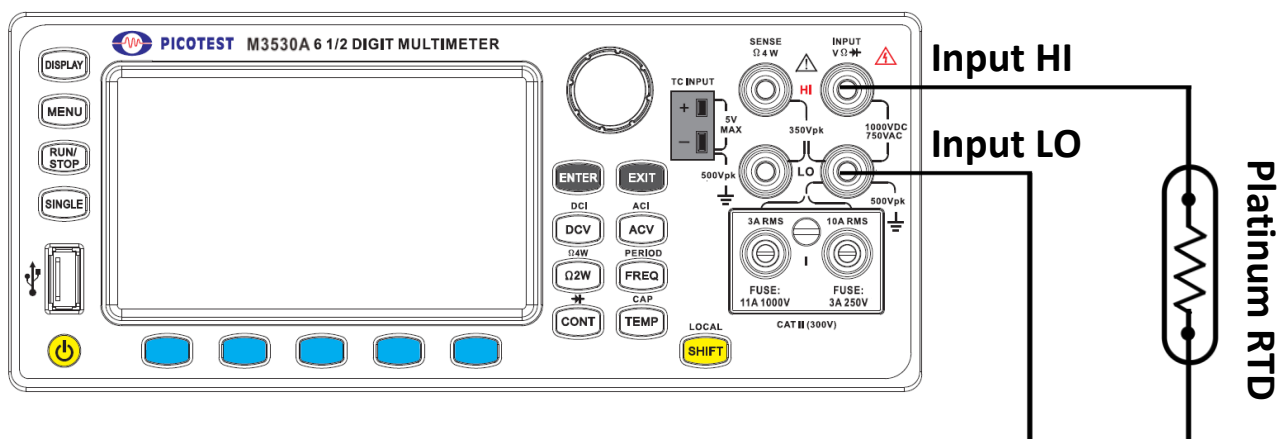
(※ Note: Source current flows from the INPUT HI to INPUT LO terminals.)

How to measure temperature with 2-Wire RTD
Through the above alternative connection, before measuring 2W RTD, you also need to finish the following setup.

● Insert a spec-compliant RTD adapter (you bought from a supplier) into the front terminals. Connect a 4-pin male microphone plug or the low thermal patch leads to the adapter.
● Configure the Transducer to RTD2W, and the Type, the Integration, the Null, the Filter, the Math, the Read Hold, the Auto Zero, the Trigger, or the Display. For more information, refer to the section 4.1.8.
● Press TEMP button.
● Place the RTD test end to the desired position and take the reading on the display.

3.8.2.2 RTD Measurement in 3 Wiring

From the above RTD principle, let's get to see the RTD measurement in 3 wiring with M3530A . The following pictures are the RTD diagram, and the RTD adapter connected with the front panel of M3530A .

1. RTD Diagram
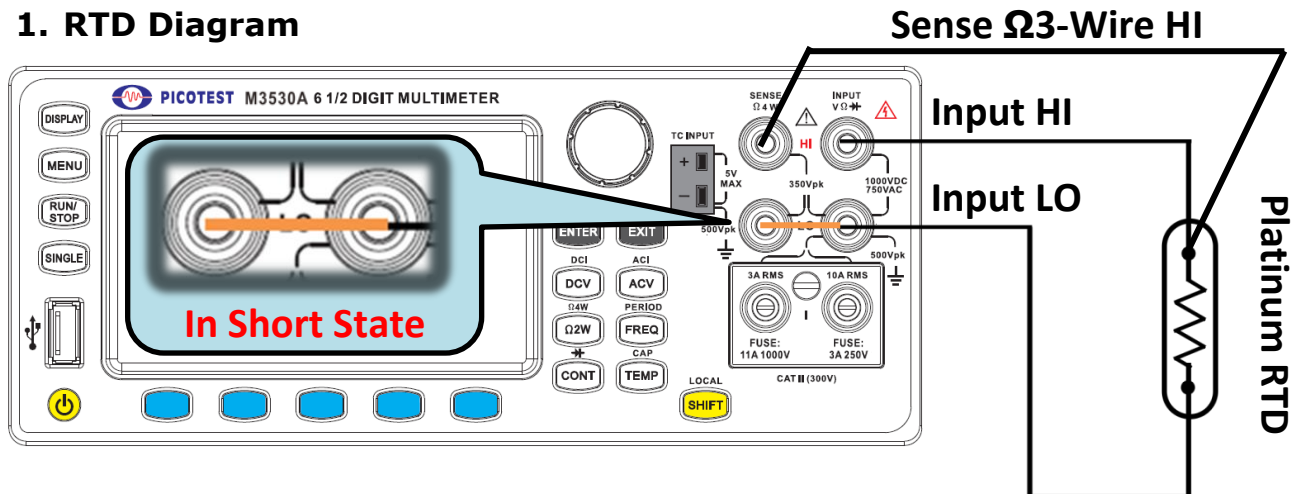
(※ Note: When conducting the 3-wire RTD measurement, the input LO and sense LO have to be connected in short condition.)

How to measure temperature with 3-Wire RTD

Through the above alternative connection, before measuring 3W RTD, you also need to finish the following setup.

- Insert a spec-compliant RTD adapter (you bought from a supplier) into the front terminals. Connect a 4-pin male microphone plug or the low thermal patch leads to the adapter..
- Configure the Transducer to RTD2W, and the Type, the Integration, the Null, the Filter, the Math, the Read Hold, the Auto Zero, the Trigger, or the Display. For more information, refer to the section 4.1.8.
- Press TEMP button.
- Place the RTD test end to the desired position and take the reading on the display.

3.8.3 Thermistor Measurement

A thermistor is a type of resistor whose resistance is strongly dependent on temperature, more so than in standard resistors. The word is a combination of thermal and resistor. Thermistors are widely used as inrush current limiters, temperature sensors (negative temperature coefficient or NTC type typically), self-resetting overcurrent protectors, and self-regulating heating elements (positive temperature coefficient or PTC type typically).

Thermistors are of two opposite fundamental types:

- With NTC thermistors, resistance decreases as temperature rises usually due to an increase in conduction electrons bumped up by thermal agitation from valency band. An NTC is commonly used as a temperature sensor, or in   with a circuit as an inrush current limiter.
- With PTC thermistors, resistance increases as temperature rises usually due to increased thermal lattice agitations particularly those of impurities and imperfections. PTC thermistors are commonly installed in   with a circuit, and used to protect against overcurrent conditions, as resettable fuses.

Here the M3530A   provides 2W & 4W thermistor types, such as 2252Ω, 5KΩ, 10KΩ, or NTC_USER.

How to measure temperature with thermistor types:
- Insert a thermistor adapter into the front terminals. (Refer to RTD 2W/4W connection)
- Configure the Transducer to Therm2W/4W, and the Type, the Integration, the Null, the Filter, the Math, the Read Hold, the Auto Zero, the Trigger, or the Display. For more information, refer to the section 4.1.8.
- Press TEMP button.
- Place the thermistor test end to the desired position and take the reading on the display.

3.9 Optocoupler CTR Measurement

M3530A applying with the accessory, J2200A, supports DC/$\triangle$ CTR (Current Transform Ratio) measurement which can be used as …

1. An IQC tester for identifying real or fake optocoupler units.
2. A classifier for factory workers to rank and mark the optocoupler's DC CTR values.
3. A circuit-design tool for engineers to match one optocouple's DC CTR or Delta CTR value with another.

This application will cost down and save much time. The connection is easy. Just plug a Type-C USB cord to the both ends of a J2200A and an M3530A. Then the testing state will display on the M3530A. For more information, check the link.

4 Front Panel Operations

This chapter contains information about how to change the parameters and setup for your measurement and all the details about feature and function.

4.1 Measurement Configuration

The following information will guide you through the specific ways to configure measurement functions. It provides you the flexibility to change any parameter in any measurement function when needed, including ADC setup, filter, resolution setup (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)

Users are allowed to enable/disable the Auto Zero function when they are under the DCV/DCI/Ω2W. In addition, this function keeps enabling when they are under Ω4W/RATIO.

Definition
The purpose of Auto Zero function is used for minimizing the offset influence on your measurements. When Auto Zero is enabled, M3530A 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 setup.

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

How to set Auto Zero
You can change the Auto Zero setup through the front panel or the command operation.

1. Front Panel Operation

For the front panel operation, users can follow one of three kinds of measurement setting methods instructed at the beginning of the Chapter 3 to set. Be aware of that Auto Zero setup is always affected by the resolution setup. Whenever the resolution is altered, Auto Zero may be changed accordingly.

First of all, you have to press the DCV function button, and check whether the upper left corner shows DC VOLTAGE as the figure below (see **Figure 4-1**).

Then, through one of the following ways of setting up ADC to enable/disable the AUTO ZERO,

1) Check the bottom line of the display, and reach to the selection of Auto Zero. Press the corresponding soft-key below to enable/disable Auto Zero. When it's enabled, the AZERO will show up as shown below.
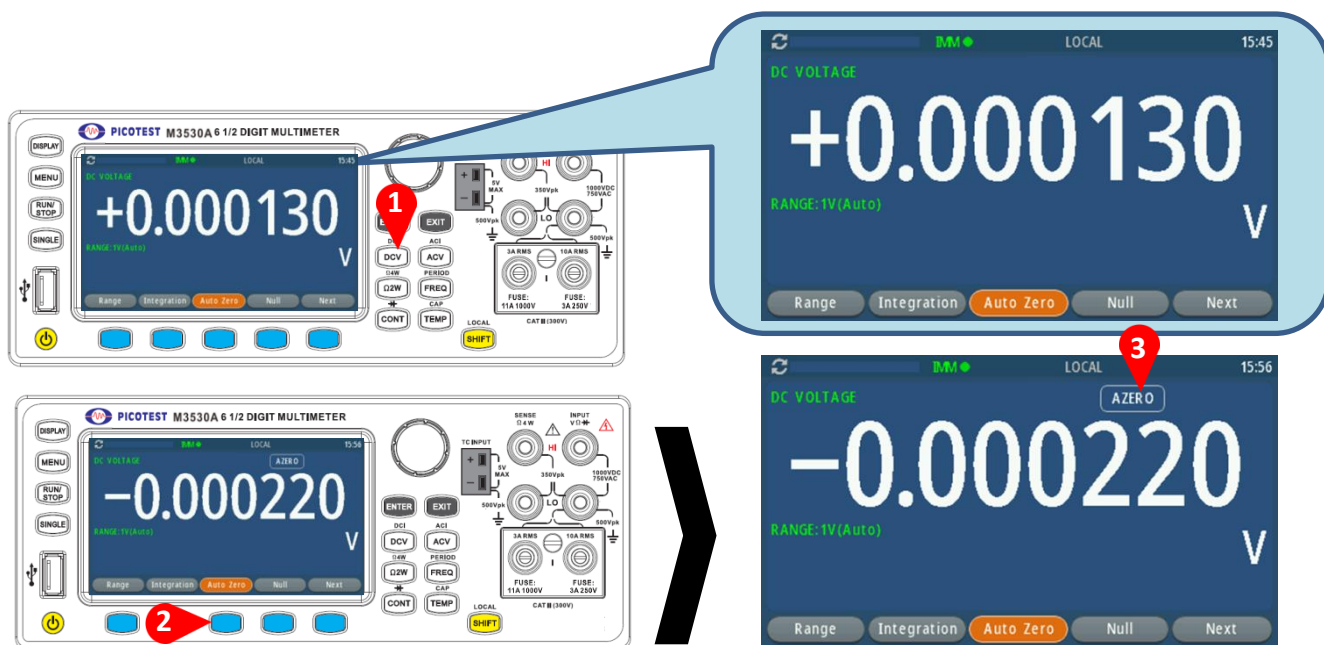
The Auto Zero via the Soft-Key Operation
Figure 4-1

2) Press the DCV function button on the front panel for 2 seconds. Reach the selection of Auto Zero. Press the Enter button to enable/disable the Auto Zero (see the **Figure 4-2**).
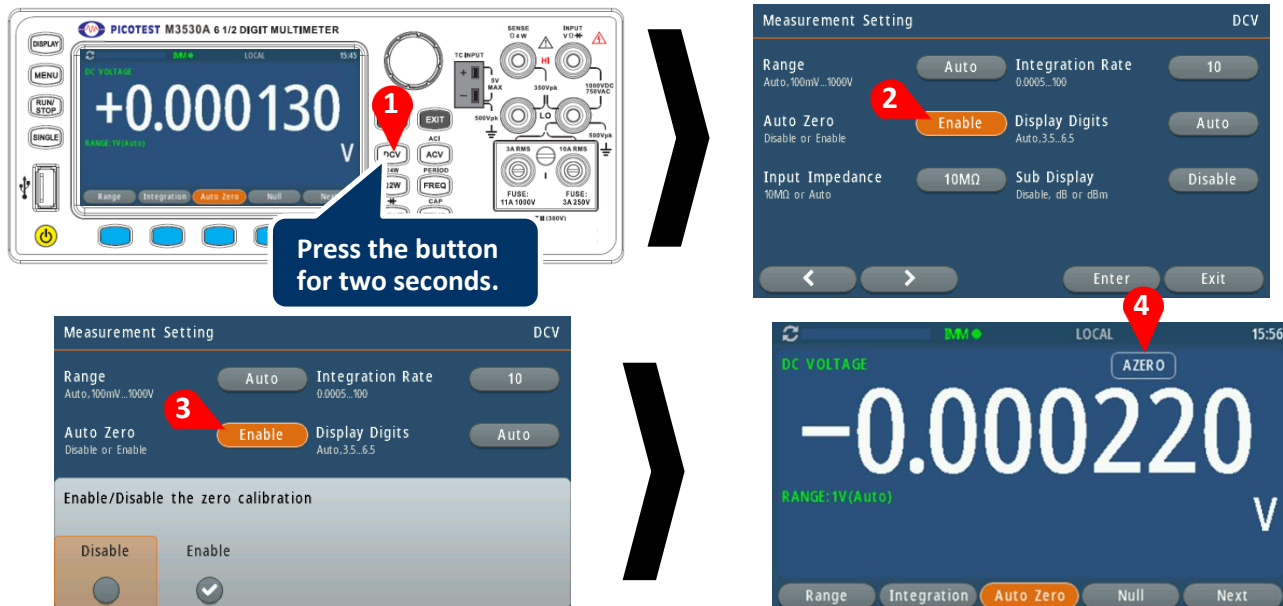
The Auto Zero via the Function-Button Operation
Figure 4-2

3) Press the MENU button on the front panel. Excess the Measurement Setting. Reach the selection of Auto Zero. Press the Enter button to enable/disable the Auto Zero (see the **Figure 4-3**).
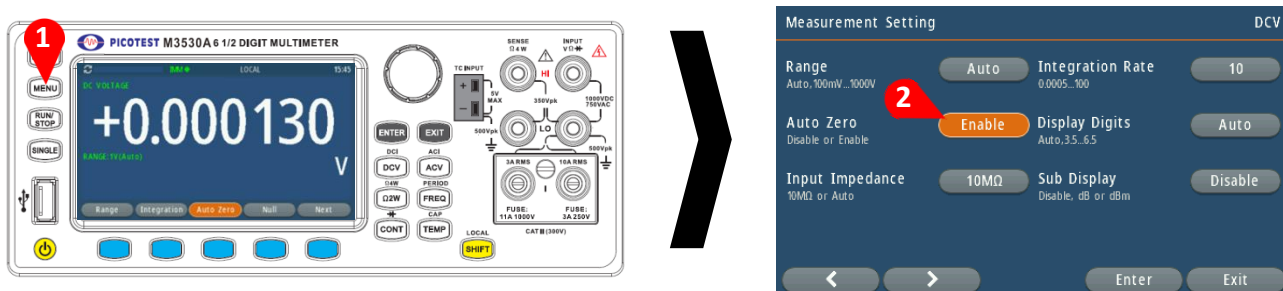
The Auto Zero via the MENU-Button Operation
Figure 4-3

※ Note: To change resolution, refer to Section 4.1.3.

2. Command 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 when measuring readings. The M3530A 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 M3530A to yield a measurement reading. Digital filter further stabilizes the measurement readings by averaging. Both of them are described in detail in the subsequent sections respectively.

4.1.2.1 AC Filter

Definition:
You are allowed to set the bandwidth for selecting one of the three AC filters (200Hz/20Hz/3Hz), in order to achieve either higher accuracy in low frequency measurements or faster AC settling time.

Defaults
The factory default is 20Hz. Refering to Table 4-1 Bandwidth with the Time-Taken, You can select the filter type as you wish when setting up bandwidth value. The selection is stored in a volatile memory and the default setup will be restored when the meter is power-off.

Table 4-1

Bandwidth	Digits	Time-Taken (seconds per reading)
3 Hz	5.5	333ms
20 Hz	5.5	50ms
200 Hz	5.5	5ms

The above data are based on the conditions of the Auto-Range, the enabled Filer, the Bandwidth in 3Hz/20Hz/200Hz, Repeat Filter Type, and 10 Filter Counts.

How to set AC Filter in AC measurements:
You can set the AC Filter either through the front panel operation or the command operation.

1. Front Panel Operation
You can configure the AC filter either through the soft-key or the menu-button.

A. The Soft-Key Method

- Press the ACV function button, and check whether the upper left corner with the red underline shows AC VOLTAGE as the figure below.
- Check the bottom line of the display, and find out the soft-key corresponding to the Filter.
- Press the soft-key once to enable the filter. When the filter is enabled, the FILT underlined green will show up on the display.
- Press the soft-key for two seconds. The complete setup will show up.
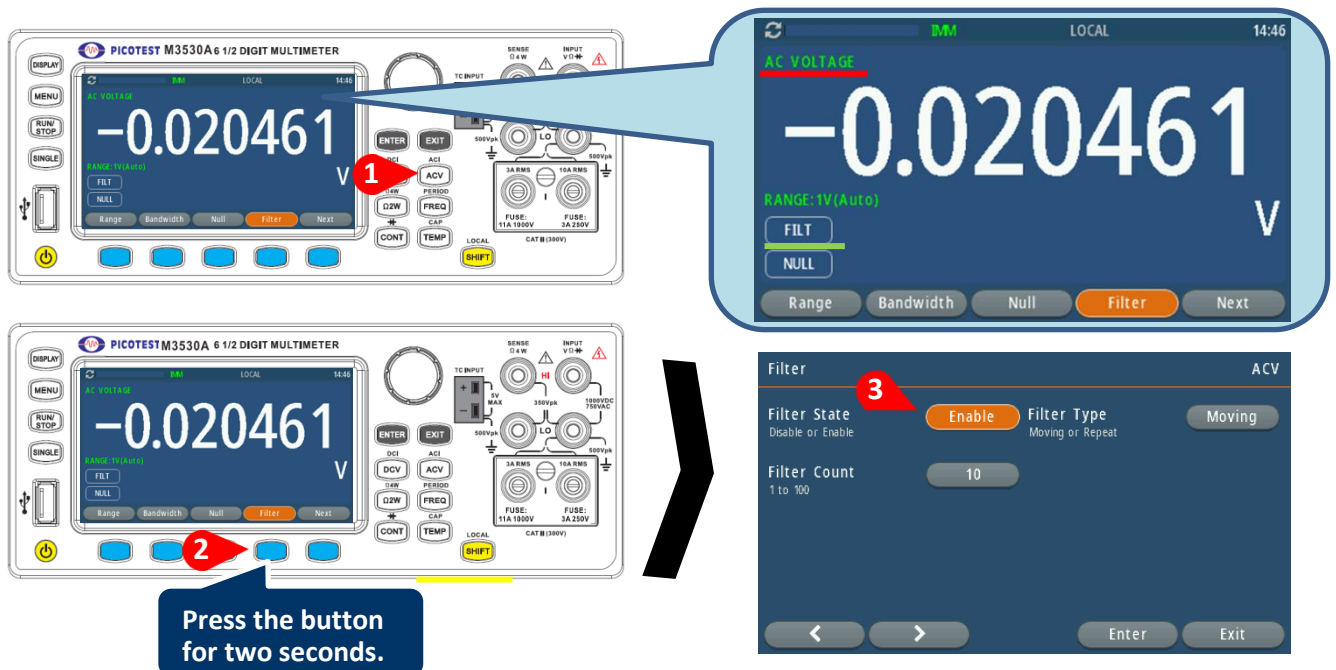
The AC Filter Setup via the Soft-Key Operation
Figure 4-4

B. The MENU-Button Method

- Press the ACV function button, and check whether the upper left corner with the red underline shows AC VOLTAGE as the figure below.
- Press the MENU button.
- Access the Measurement Calculations.
- You will see the Filter state (Enable/Disable). Enter it for complete setup.
- Press the MENU button on the front panel. Excess the Measurement Calculations. Reach the selection of the Filter. Press the Enter button to set the Filter. Once this Filter function is enabled, the indicator of FILT underlined green will show up on the display.
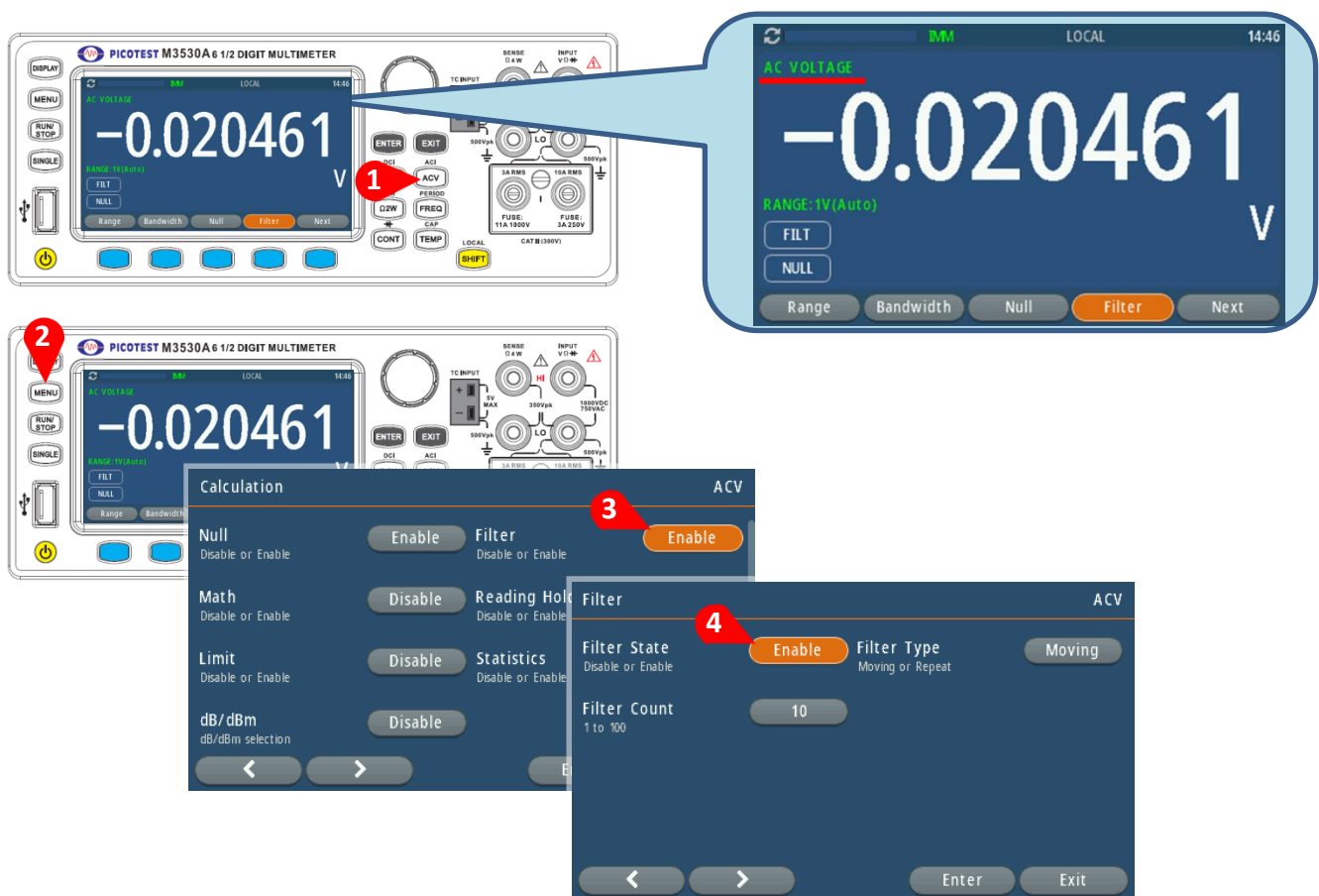
The AC Filter Setup via the MENU-button Operation
Figure 4-5

2. Command 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

M3530A 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 or Repeating Average.

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

Default

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

How to enable/disable digital filter

Press the Filter button to switch the digital filter function. The "FILT" annunciator indicates the state of the digital filter. When it is lit, the filter is enabled.

How to configure digital filter:

You can configure the digital Filter either through the front panel operation or the command operation.

1. Front Panel Operation

You can configure the digital filter either through the soft-key or the menu-button.

A. The Soft-Key Method

For the filter count setup (from 2 to 100), please press the soft-key corresponding to the Filter located at the bottom of the display for two seconds (see **Figure 4-6**).
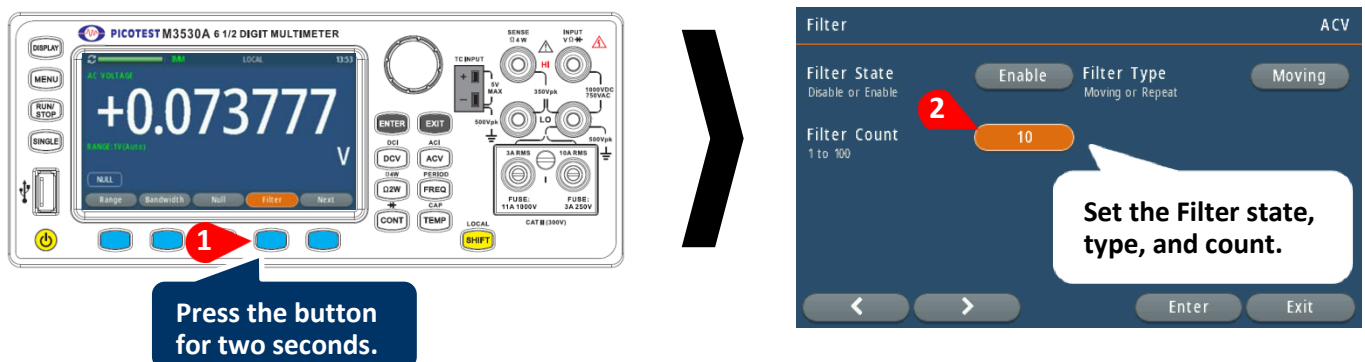
The Digital Filter via the Soft-Key Operation
Figure 4-6

B. The MENU-Button Method

Press the buttons through the path: MENU > Calculations > Filter (see **Figure 4-7**). During the operation, the direction soft-keys or the knob will be used. And do the same to set the Filter Type (Moving/Repeat) or the Filter State (Enable/Disable).
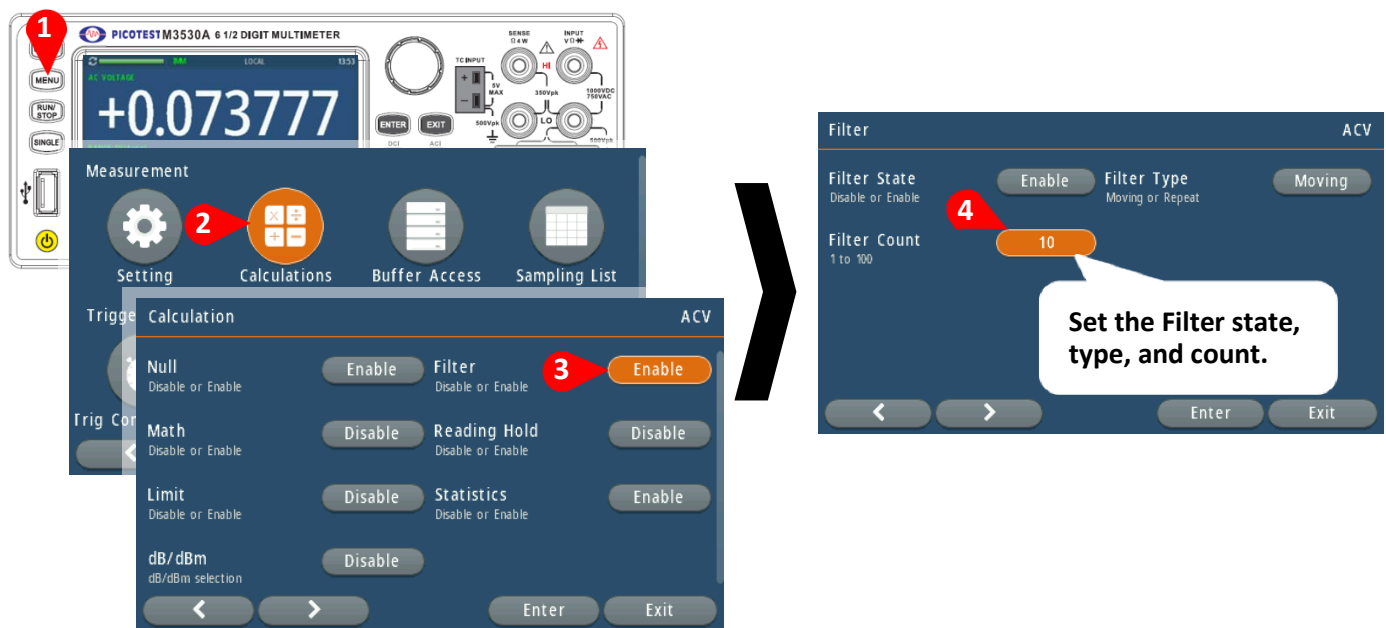
The Digital Filter via the MENU-Button Operation
Figure 4-7

2. Command 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 Setup (Digits)

While measuring DC and resistance, resolution with the number of digits on a multimeter is visible. You can select the resolution for a specific measurement. For a higher accuracy, you can select 1NPLC. For a faster measurement, you can select 0.0008NPLC.

While measuring ACI & ACV, the default is 5.5 digits. Under frequency and period measurements, the way of the Aperture Time and the Gate Time are similar to the integration time, for example, 0.0008, 0.0016, 0.0024, NPLC for 4.5 digits, 0.008, 0.02, 0.06, 0.2 for 5.5digis, and 1, 10 & 100 NPLC for 6.5 digits.

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

Default
The default value for the resolution is slow 6.5 digits and the default value will be restored when the meter has been turned off or after a remote interface reset. The user selected value for the resolution setup is stored in a volatile memory and the setup is only valid for the current measurement function. Please refer to **Table 2-1** on page 22.

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

1. Front Panel Operation
You can configure the resolution (digits) either through the soft-key or the menu-button.

A. The Soft-Key Method
● Select your measurement function first by pressing one of the function buttons located on the front panel, for emple: DCV.
● For the digits setup (Auto, 3.5, 4.5, 5.5, or 6.5), please press the soft-key corresponding to the Integration located at the bottom of the display for two seconds (see **Figure 4-8**).
● You will see the Display Digits. The default of the Display Digits is Auto. If you would like to choose other digits, enter the setup, you will see 3.5, 4.5, 5.5, and 6.5 down there.
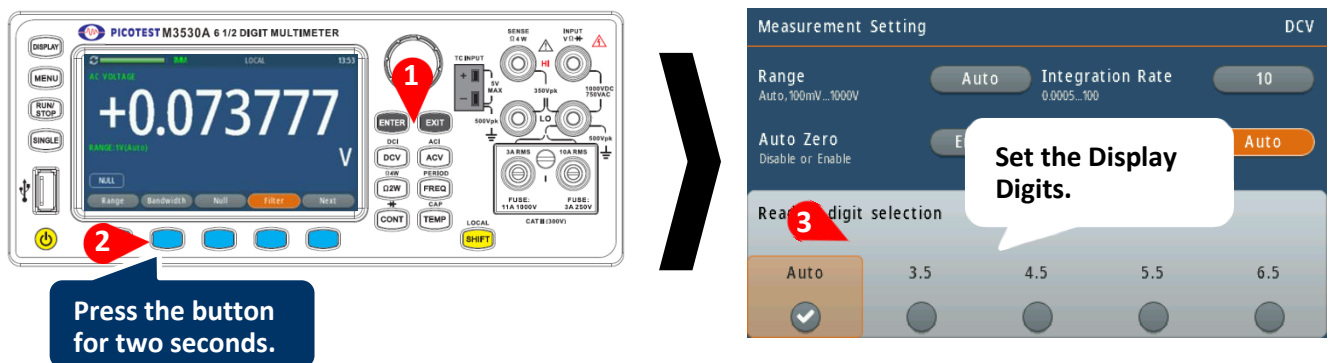
The Resolution Setup via the Soft-Key Operation
Figure 4-8

B. The MENU-Button Method
● Select your measurement function first by pressing one of the function buttons located on the front panel, for emple: DCV.
● Press the MENU button, and select the Measurement Setting to enter. (see **Figure 4-9**).
● You will see the Display Digits. The default of the Display Digits is Auto. If you would like to choose other digits, enter the setup, you will see 3.5, 4.5, 5.5, and 6.5 down there.

The Resolution Setup via the MENU-Button Operation
Figure 4-9

※ Note: Through the same method, users are also allowed to set the Range, Integration Rate, Auto Zero, Input Impedance, and Sub Display.

※ Note: When using Method A to change the digits on DCV, DCI, 2W, 4W, Frequency, Period, ACV, and ACI functions, the default of AUTO will be applied.

2. Command Operation

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

CONFigure:<function> <range>,<resolution>
MEASure:<function>? <range>,<resolution>
SENSe:<function>:RESolution <resolution>
FREQuency:APERture {0.001|0.01|0.1|1|MIN|MAX}
PERiod:APERture {0.001|0.01|0.1|1|MIN|MAX}

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

CONF:VOLT:DC 10,0.0008   (4 1/2 digits on the 10 Vdc range)
MEAS:CURR:AC? 1,1E-6   (6 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 ms resolution on the ac function)

4.1.4 DC Input Resistance

To reduce the effect of loading errors due to the input resistance, M3530A allows you to select a much larger input resistance (HighZ>10GΩ/Auto) for all range measurements. This feature is only available for DC voltage measurements and it is not applicable to other measurement functions. The default at all ranges is 10MΩ. Also note that the selected value by users is stored in a volatile memory. The default setup will be restored after the meter has been turned off.

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

1. Front Panel Operation
You can configure the DC input resistance either through the soft-key or the menu-button.

A. The Soft-Key Method
- Select the DCV function first on the front panel.
- For the DC input impedance setup (Auto or 10MΩ), please press the soft-key corresponding to the Integration located at the bottom of the display for two seconds (See **Figure 4-10**).
- You will see the setup. The default is 10MΩ. You're also allowed to select Auto (>10GΩ).
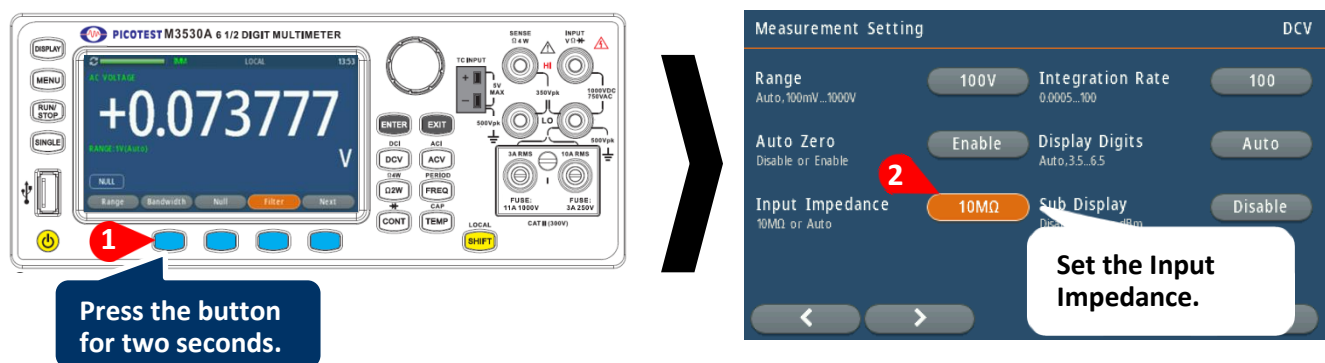
The Impedance Setup via the Soft-Key Operation
Figure 4-10

B. The MENU-Button Method
- Select the DCV function first on the front panel.
- Press the MENU button, and select the Measurement Setting to enter. (See **Figure 4-11**).
- You will see the setup. The default is 10MΩ. You're also allowed to select Auto (>10GΩ).
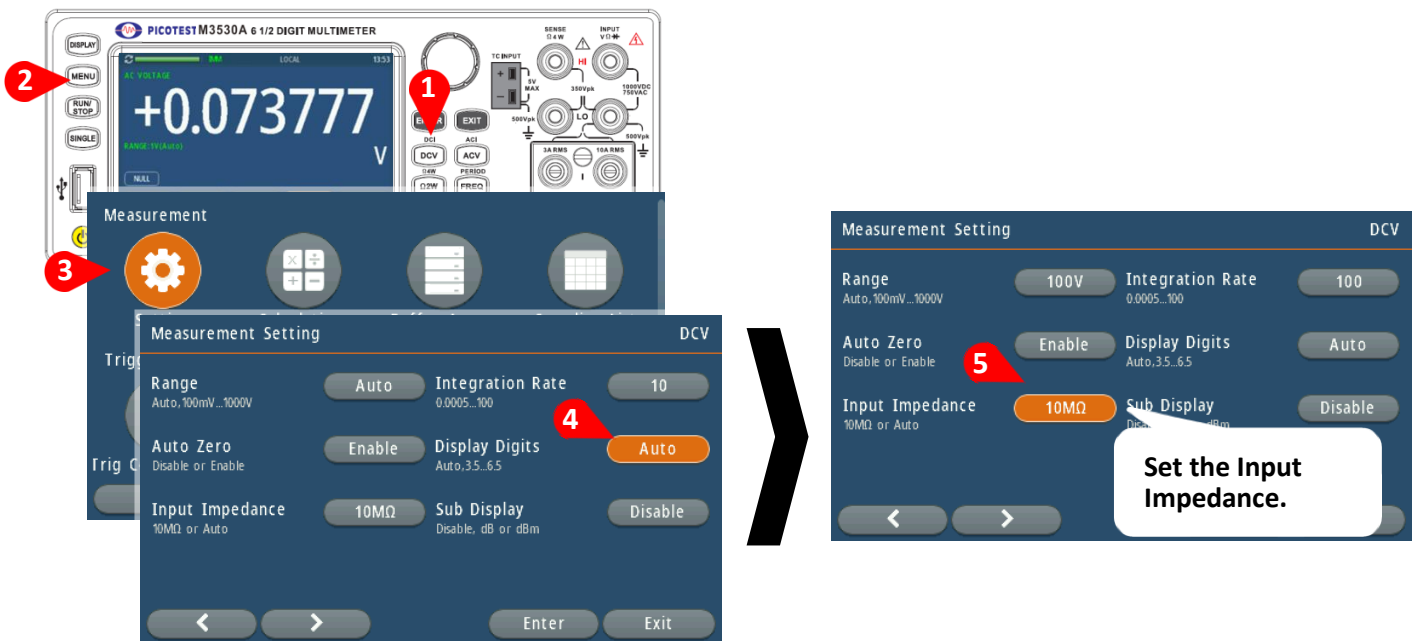
The Impedance Setup via the MENU-Button Operation

Figure 4-11

2. Command Operation

Use the following commands with your PC to set the input impedance for your measurement.

INPut:IMPedance:AUTO {OFF | ON}

4.1.5 Threshold Resistance (Continuity) Setup

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 1200Ω.

Default

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

How to set the threshold resistance

You can set the threshold either through the front panel operation or the command operation.

1. Front Panel Operation

● Press the CONT button on the front panel.
● Press the soft-key corresponding to the Threshold located once at the bottom of the display (See **Figure 4-12**).
● Use the soft-key or knob to adjust the parameter. When finishing the setup, press

Enter to apply.
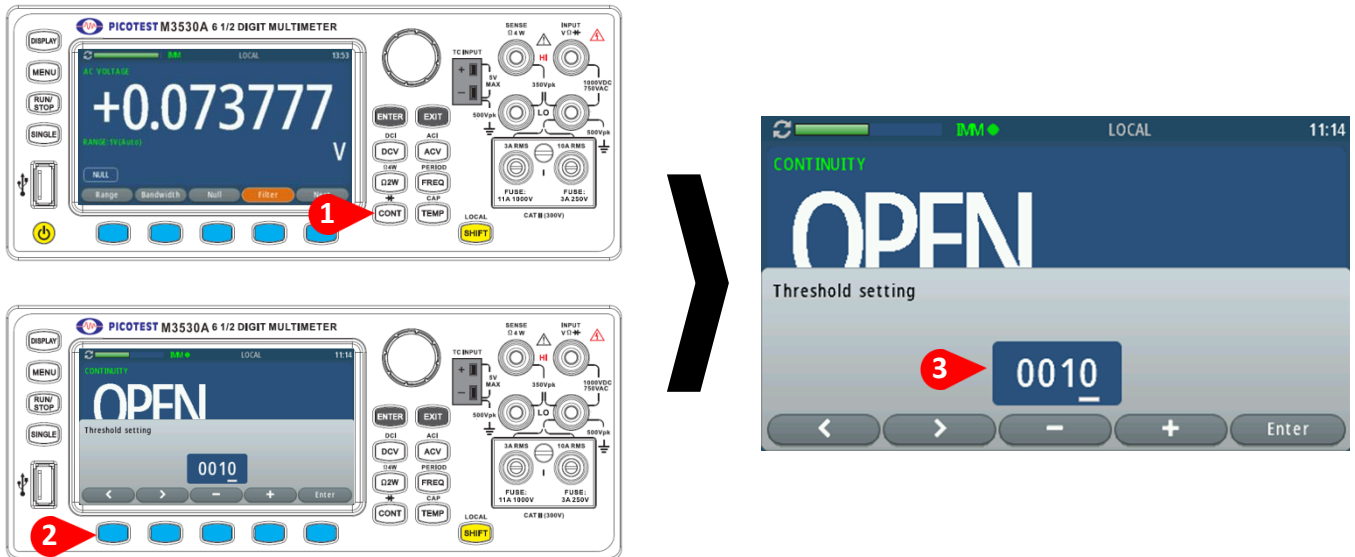
The Threshold Setup via the Soft-Key Operation
Figure 4-12

4.1.6 Range (Manual & Auto)

When making measurements except CONT, DIODE and Temperature, you can let the machine choose a range for you, or you can select the appropriate ranges manually by yourself. The difference between auto-range and manual-range is the settling time. Auto-range is a convenient way for 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 user selected range is stored in volatile memory and the default will be restored when the meter is power-off. Please refer to **Table 2-1** on page 20 for the factory default range**.**

The Auto range on DCV/DCI/ACV/ACI/2WΩ/4WΩ/FREQ/RATIO/CAP is automatically enabled, and set as a default. For other range selection, you have to manually set as the procedures below.

How to set the auto / manual range:
You can set the auto / manual range either through the front panel operation or the command operation.

1. Front Panel Operation

- Set the DCV function on the front panel for emple.
- Connect the no-powered unit (DUT) to the Input HI and LO of M3530A .
- Turn on the power of the DUT.
- Your M3530A will automatically pick a proper range for your input source (see **Figure 4-13**). If you would like to pick other range, press the soft-key corresponding to the Range, and select a higher ranger. Otherwise, the +Overload will show up (see **Figure 4-14**).
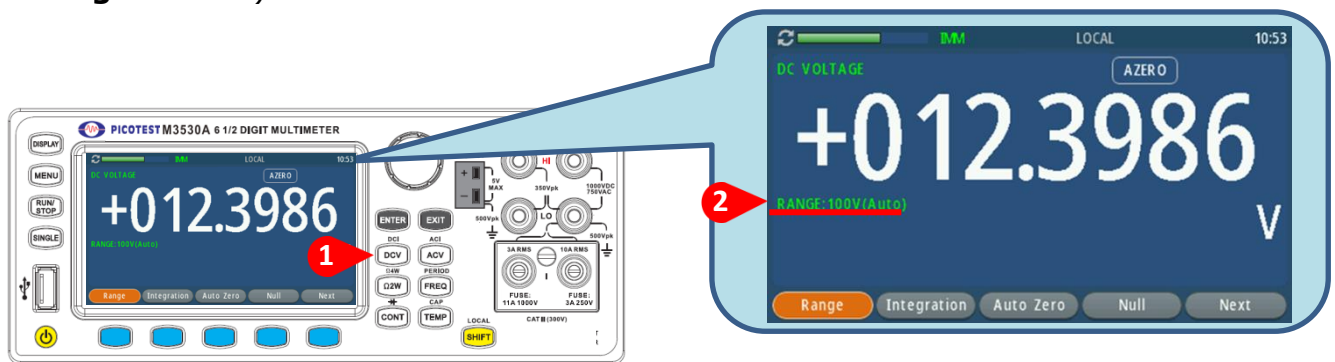
The AUTO Range Setup via the Soft-Key Operation

Figure 4-13
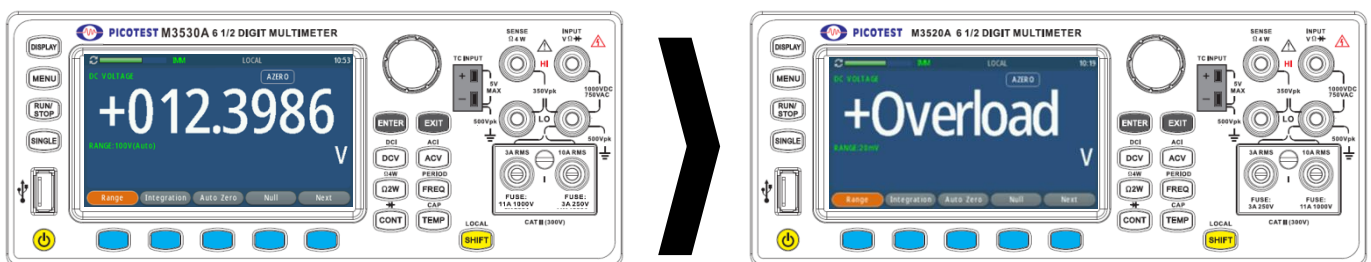
Overload Shows Up when Picking an Incorrect Range

Figure 4-14

2. Command 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}

4.1.7 Integration

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 several integration times in M3530A for you to select from: 0.0008, 0.0016, 0.0024 NPLC for 4.5 digits, 0.008, 0.02, 0.06, 0.2 for 5.5digis, and 1, 10 & 100 NPLC for 6.5 digits.

Default
For DCV, DCI, and resistance measurement, the default integration time is 10 PLC. The user selected value is stored in a volatile memory and the default value will be restored when the meter is power-off.

How to set the integration time:
You can set the integration time either through the front panel operation or the command operation.

Front Panel Operation
You can configure the Integration either through the soft-key or the menu-button.

A. The Soft-Key Method
- Select your measurement function first by pressing one of the function buttons located on the front panel, for emple: DCV.
- For the Integration setup, please press the soft-key corresponding to the Integration 0.0008, 0.0016, 0.0024, 0.008, 0.02, 0.06, 0.2, 1, 10 & 100 NPLC located at the bottom of the display (see **Figure 4-15**).
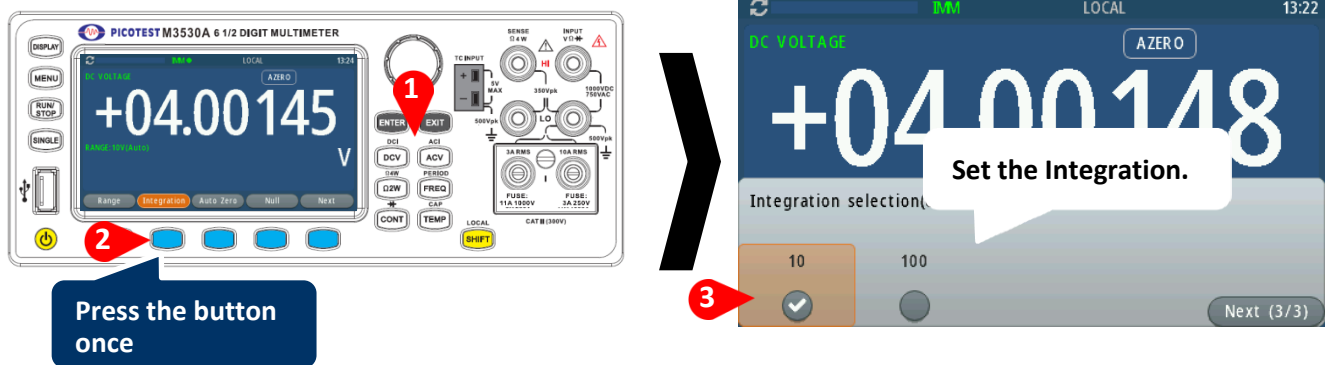
The Integration Setup via the Soft-Key Operation
Figure 4-15

B. The MENU-Button Method
- Select your measurement function first by pressing one of the function buttons located on the front panel, for emple: DCV.
- Press the MENU button, and select the Measurement Setting to enter. (See **Figure 4-16**).
- You will see the Integration. The default is 1 NPLC. If you would like to choose other

digits, enter the setup, you will see 0.0008, 0.0016, 0.0024, 0.008, 0.02, 0.06, 0.2, 1, 10 & 100 NPLC down there.
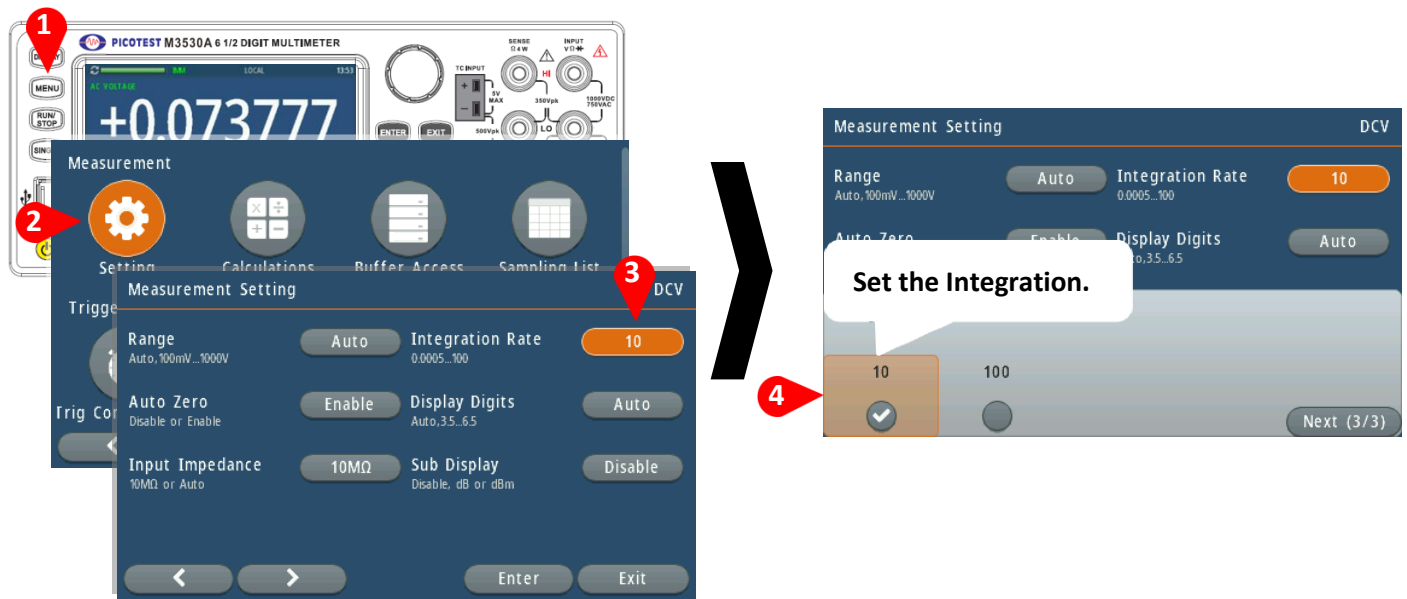
The Resolution Setup via the MENU-Button Operation
Figure 4-16

※ Note: Through the same method, users are also allowed to set the Range, Rate, Auto Zero, Display Digits, Input Impedance, and Sub Display.

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

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

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

SENSe:VOLTage:DC:NPLCycles
{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|1|10|100|MINimum|MAXimum}
SENSe:VOLTage:DC:NPLCycles? [MINimum|MAXimum]
SENSe:CURRent:DC:NPLCycles
{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|1|10|100|MINimum|MAXimum}
SENSe:CURRent:DC:NPLCycles? [MINimum|MAXimum]
SENSe:RESistance:NPLCycles
{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|1|10|100|MINimum|MAXimum}
SENSe:RESistance:NPLCycles? [MINimum|MAXimum]
SENSe:FRESistance:NPLCycles
{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|1|10|100|MINimum|MAXimum}
SENSe:FRESistance:NPLCycles? [MINimum|MAXimum]

For frequency and period measurements, aperture time (or gate time) is analogous to integration time, and you can use the following commands to set it. Specify 10 ms (4.5 digits), 100 ms (default; 5.5 digits), or 1 second (6.5 digits).

SENSe:FREQuency:APERture {0.001|0.01|0.1|1|MINimum|MAXimum}
SENSe:FREQuency:APERture? [MINimum|MAXimum]
SENSe:PERiod:APERture {0.001|0.01|0.1|1|MINimum|MAXimum}
SENSe:PERiod:APERture? [MINimum|MAXimum]

The following **table 4-2** shows the relationship between the integration time and the measurement resolution.

Table 4-2

Integration Time(PLC)	Resolution	
	DEFAULT	COMPATIBLE
0.0008		
0.0016		
0.0024		
0.008		
0.02	0.0001 x Full-Scale	0.0001 x Full-Scale
0.06		
0.2	0.00001 x Full-Scale	0.00001 x Full-Scale
1	0.000001 x Full-Scale	0.000003 x Full-Scale
10	0.0000001 x Full-Scale	0.000001 x Full-Scale
100		

4.1.8 Sensor Selection for Temperature Measurements

The multimeter supports thermistor, thermocouple and RTD. You need to configure the multimeter for the right sensor type, units and transducer before conducting temperature measurements.

4.1.8.1 Thermistor

A thermistor is a type of resistor whose resistance is dependent on temperature, more so than in standard resistors. The word is a combination of thermal and resistor. Thermistors are widely used as inrush current limiters, temperature sensors (negative temperature

coefficient or NTC type typically), self-resetting overcurrent protectors, and self-regulating heating elements (positive temperature coefficient or PTC type typically).

Thermistors are of two opposite fundamental types:

● With NTC thermistors, resistance decreases as temperature rises. An NTC is commonly used as a temperature sensor, or in   with a circuit as an inrush current limiter.
● With PTC thermistors, resistance increases as temperature rises. PTC thermistors are commonly installed in   with a circuit, and used to protect against overcurrent conditions, as resettable fuses.

Thermistors are generally produced using powdered metal oxides. With vastly improved formulas and techniques over the past 20 years, NTC thermistors can now achieve accuracies over wide temperature ranges such as ±0.1 °C or ±0.2 °C from 0 °C to 70 °C with excellent long-term stability. NTC thermistor elements come in many styles such as axial-leaded glass-encapsulated (DO-35, DO-34 and DO-41 diodes), glass-coated chips, epoxy-coated with bare or insulated lead wire and surface-mount, as well as rods and discs. The typical operating temperature range of a thermistor is −55 °C to +150 °C, though some glass-body thermistors have a maximal operating temperature of +300 °C.

Thermistors differ from resistance temperature detectors (RTDs) in that the material used in a thermistor is generally a ceramic or polymer, while RTDs use pure metals. The temperature response is also different; RTDs are useful over larger temperature ranges, while thermistors typically achieve a greater precision within a limited temperature range, typically −90 °C to 130 °C.

Basic operation

Assuming, as a first-order approximation, that the relationship between resistance and temperature is linear, then

$$\Delta R = k \Delta T, {\displaystyle \Delta R=k\Delta T,}$$

where

   ΔR, change in resistance,
   ΔT, change in temperature,
   k, first-order temperature coefficient of resistance.

Thermistors can be classified into two types, depending on the sign of k. If k is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (PTC) thermistor, or **posistor**. If k is negative, the resistance decreases with increasing temperature, and the device is called a negative temperature coefficient (NTC) thermistor. Resistors that are not thermistors are designed to have a k

as close to 0 as possible, so that their resistance remains nearly constant over a wide temperature range.

Instead of the temperature coefficient k, sometimes the temperature coefficient of resistance α T ("alpha sub T") is used. It is defined as

$$\alpha_T = \frac{1}{R(T)} \frac{dR}{dT}.$$

4.1.8.2 Thermocouple

A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming an electrical junction. A thermocouple produces a temperature-dependent voltage as a result of the thermoelectric effect, and this voltage can be interpreted to measure temperature. Thermocouples are a widely used type of temperature sensor.

Commercial thermocouples are inexpensive, interchangeable, are supplied with standard connectors, and can measure a wide range of temperatures. In contrast to most other methods of temperature measurement, thermocouples are self-powered and require no external form of excitation. The main limitation with thermocouples is precision; system errors of less than one degree Celsius (°C) can be difficult to achieve.

Thermocouples are widely used in science and industry. Applications include temperature measurement for kilns, gas turbine exhaust, diesel engines, and other industrial processes. Thermocouples are also used in homes, offices and businesses as the temperature sensors in thermostats, and also as flame sensors in safety devices for gas-powered appliances.

Basic operation
When different metals are joined at the ends and there is a temperature difference between the joints, a magnetic field is observed. At the time, Seebeck referred to this consequence as thermo-magnetism. The magnetic field he observed was later shown to be due to thermo-electric current. In practical use, the voltage generated at a single junction of two different types of wire is what is of interest as this can be used to measure temperature at very high and low temperatures. The magnitude of the voltage depends on the types of wire being used. Generally, the voltage is in the microvolt range and care must be taken to obtain a usable measurement. Although very little current flows, power can be generated by a single thermocouple junction. Power generation using multiple thermocouples, as in a thermopile, is common.
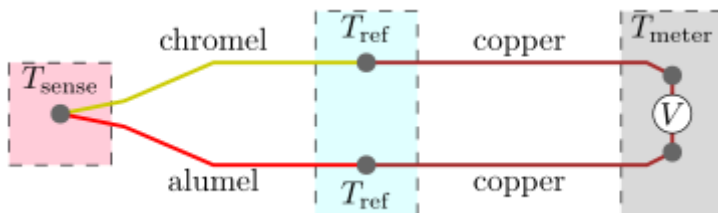
K-type thermocouple (chromel–alumel) is in the standard thermocouple measurement configuration. The measured voltage V can be used to calculate temperature T_{sense}, provided that temperature T_{ref} is known.

The standard configuration for thermocouple usage is shown in the figure. Briefly, the desired temperature Tsense is obtained using three inputs—the characteristic function E(T) of the thermocouple, the measured voltage V, and the reference junctions' temperature Tref. The solution to the equation E(Tsense) = V + E(Tref) yields Tsense. These details are often hidden from the user since the reference junction block (with Tref thermometer), voltmeter, and equation solver are combined into a single product.

※ Note: The above description is quoted from
https://en.wikipedia.org/wiki/Thermocouple

If you are using the thermocouple function on the M3530A, the available selections are: type K, J, R, S, B, T, E, N, and C.

Comparison of types
Table 4-4 below describes properties of several different thermocouple types. Within the tolerance columns, T represents the temperature of the hot junction, in degrees Celsius. For emple, a thermocouple with a tolerance of ±0.0025×T would have a tolerance of ±2.5 °C at 1000 °C.

Table 4-4

| Type | Temperature range (℃) | | | | Tolerance class (℃) | | Color code | | |
| | Continuous | | Short-term | | One | Two | IEC[30] | BS | ANSI |
	Low	High	Low	High					
K	0	+1100	−180	+1370	−40 – 375: ±1.5 375 – 1000: ±0.004×T	−40 – 333: ±2.5 333 – 1200: ±0.0075×T			
J	0	+750	−180	+800	−40 – 375: ±1.5 375 – 750: ±0.004×T	−40 – 333: ±2.5 333 – 750: ±0.0075×T			
N	0	+1100	−270	+1300	−40 – 375: ±1.5 375 – 1000: ±0.004×T	−40 – 333: ±2.5 333 – 1200: ±0.0075×T			
R	0	+1600	−50	+1700	0 – 1100: ±1.0 1100 – 1600: ±0.003×(T−767)	0 – 600: ±1.5 600 – 1600: ±0.0025×T			Not defined
S	0	+1600	−50	+1750	0 – 1100: ±1.0 1100 – 1600: ±0.003×(T−767)	0 – 600: ±1.5 600 – 1600: ±0.0025×T			Not defined
B	+200	+1700	0	+1820	Not available	600 – 1700: ±0.0025×T	No standard	No standard	Not defined
T	−185	+300	−250	+400	−40 – 125: ±0.5 125 – 350: ±0.004×T	−40 – 133: ±1.0 133 – 350: ±0.0075×T			
E	0	+800	40	+900	−40 – 375: ±1.5 375 – 800: ±0.004×T	−40 – 333: ±2.5 333 – 900: ±0.0075×T			
			N/A	N/A	Reproducibility 0.2% of the voltage.				

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

1. Front Panel Operation

- Select the temperature function pressing the TEMP button.
- Input the thermocouple adapter, and wire it to your DUT.
- Press the soft-key corresponding to the Transducer, and then TCO.
- Press the Exit button once, and the soft-key to the Type (**See Figure 4-17**).
- Select the type identical to the thermocouple adapter. Your display will show up with values.
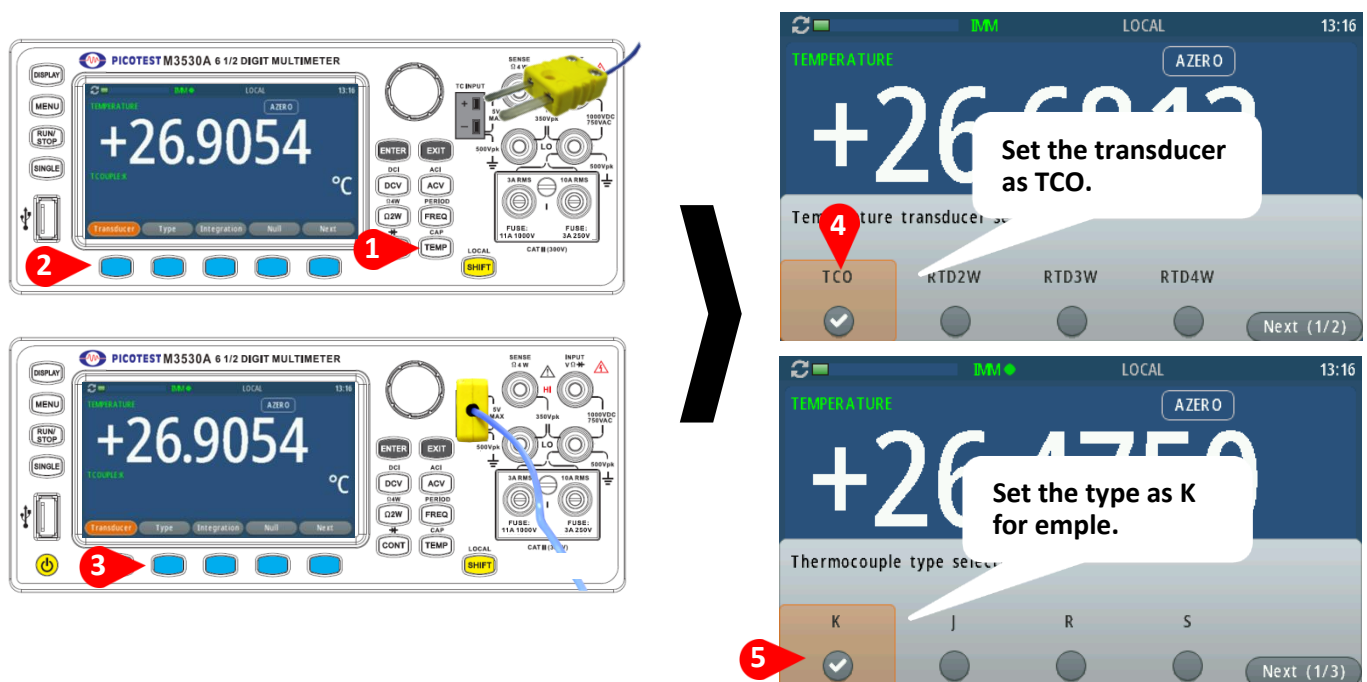
Thermocouple Setting

Figure 4-17

2. Command 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|B|C}

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

4.1.8.3 RTD

If the RTD is used, you have to confirm the RTD setup (incl. sensor, units and transducer) first throught the front penal operations or the remote control operation. For the transducer options, they are: RTD2W, RTD3W, and RTD4W. For the sensor options, they are: PT100, D100, F100, PT385, PT3916, RTD_USER, and SPRTD.

If you need to change the factors that are used to calculate the temperature in RTD, choose user-defined RTD in which you are able to change any factors as you wish. The default factors used are listed in **Table 4-3**

Table 4-3

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

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

When $t < 0°C$:

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

When $0°C < t < 630°C$:

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

Where:

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

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

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

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

The ITS (International Temperature Scale) -90 standard provides two reference equations for Standard Platinum Thermometers covering temperature range from 18.8033K to 1234.93K. However, one SPRTD usually cannot cover the entire range, so the temperature range is broken up into a few subranges. These subranges depend on the calibration point of temperature scale and are based on the melting or triple points of various pure substances. For an ect 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 transducer, and sensor type in M3530A   is RTD2W and PT100 in order.

How to set up RTD

You can set up the RTD configuration either through the front panel operation or the command operation.

1. Front Panel Operation

● Select the temperature function pressing the TEMP button.

● Input the RTD adapter, and wire it to your DUT.

● Press the soft-key corresponding to the Transducer, and then RTD2W/3W/4W.

● Press the Exit button once, and the soft-key to the Type (**See Figure 4-18**).

● Select the type identical to the RTD adapter. Your display will show up with values.
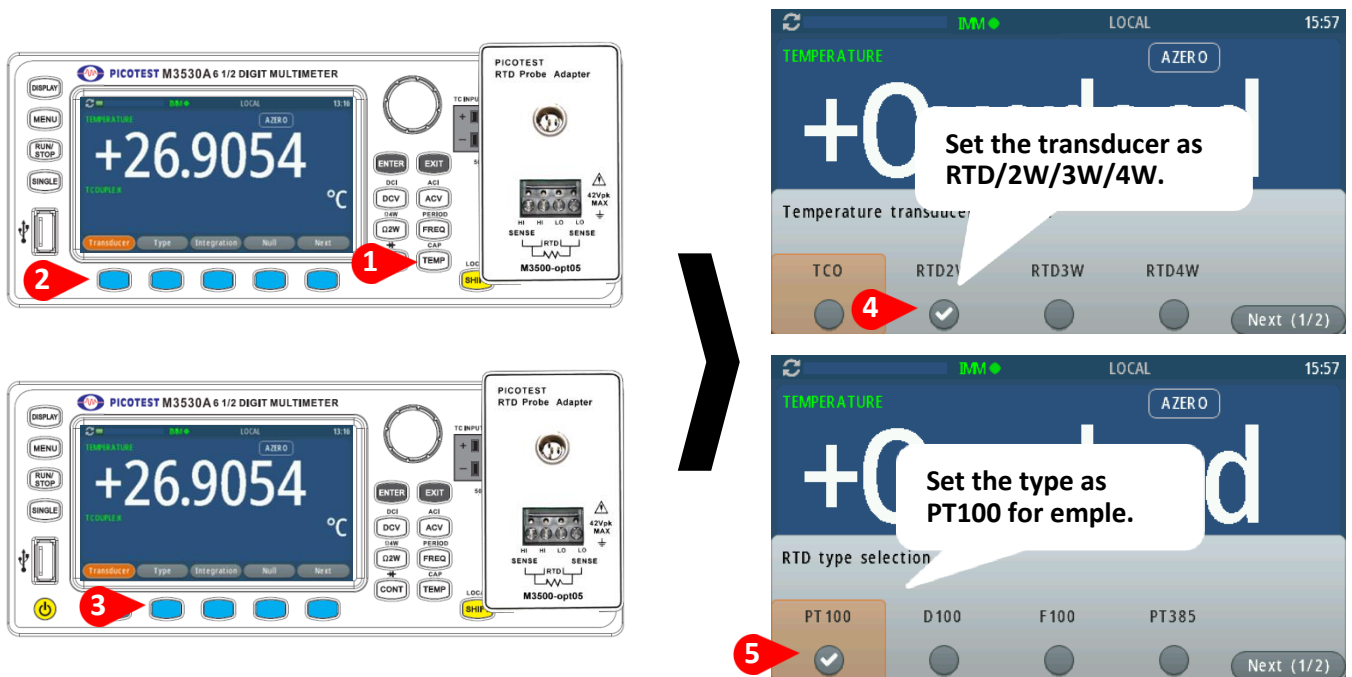
RTD Setup

Figure 4-18

2. Command Operation

Use the following commands to set up the RTD configuration.

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

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}

SENSe:TEMPerature:TRANsducer FRTD

SENSe:TEMPerature:TRANsducer RTD

4.1.9 Remote Interface Selection

The M3530A supports GPIB/RS-232 (optional), USB, and LAN interfaces, but only one interface can be activated at a time. If you are using GPIB/RS-232, you must set the same address/Boud Rate for the multimeter and the connected PC. You can set the LAN IP and your PC IP under the same router, GPIB address to any value from 0 and 31 or RS-232 Boud Rate from 9600 to 115200. The GPIB address and the boud rate are set to "22" and "9600" respectively before the multimeter is shipped from the factory.

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

How to select a remote interface

Press the MENU button, and then use the soft-key < > or rotate the knob to select Communication. Press ENTER to select your preferable interface, LAN, GPIB, USB or RS-232. And leave the required parameter in the selection or column shown below.

1. LAN Interface Setup
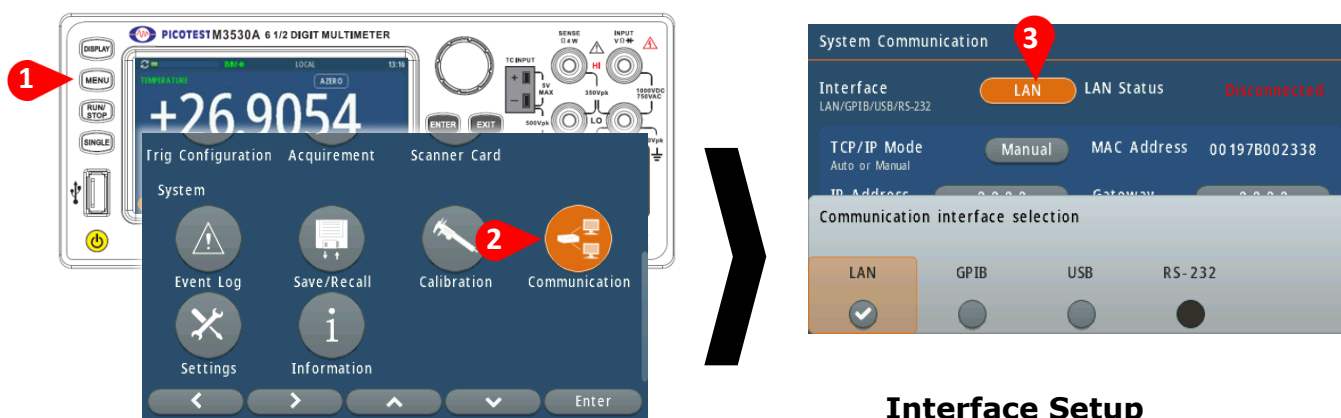
Interface Setup

Figure 4-19

LAN Setup

Figure 4-20

- **LAN Status:** If the LAN is wired correctly, the status will show "Connected"

- **TCP/IP Mode:** Auto means the IP will be automatically assigned by your router. Manual means you can leave an appointed IP Address, Gateway, and Subnet to this DMM. When the settings under the Manual mode are ready, select "Apply" to adopt.
- **LAN Reset:** When the setup is not applicable for your device, you're allowed to press Reset to clean the previous setup.

※ Note: The same IP address setup might conflict your DMM with other connected devices under the same application.

2. GPIB Interface Setup

GPIB Setup
Figure 4-21

- **Address:** This address value is allowed to set from 1 to 30. Once the address is set, set an identical address on your PC application.

※ Note1: The same GPIB address setting might conflict your DMM with other connected devices under the same application.

※ Note2: When your DMM is remotely connected at first time, your wired PC will show the unidentified information   M3530A   whose expressed style might be different from other OS version. Here it shows under Windows 10 64-bit. In this case, the USBTMC driver with the keyword "NI-VISA" can be found on the website www.ni.com. After downloading and installing, the PC will control M3530A with no problem.

3. USB Interface Setting

USB Setup

Figure 4-22

※ Note1: The same GPIB address setup might conflict your DMM with other connected devices under the same application.

※ Note2: When your DMM is remotely connected at first time, your wired PC will show the unidentified information ![M3530A] whose expressed style might be different from other OS version. Here it shows under Windows 10 64-bit. In this case, the USBTMC driver with the keyword "NI-VISA" has to be downloaded from the website www.ni.com. After downloading and installing, the PC will control M3530A with no problem.

4. RS-232 Interface Setup

RS-232 Setup

Figure 4-23

- **Baud Rate:** There are 300, 1200, 2400, 9600, 19200, 38400, 115200 for users to choose from. The default is 9600. The value has to be identical to the setting on the M3530A's/M3530A's hardware device of your PC.
- **Parity:** This setup is used to inspect the correction of data. The default is None. If you decide to use, please select odd or even to check
- **Flow Control:**
  1. **None:** Leaving it as None, the flow control will not be conducted.
  2. **Xon/Xoff:** Two bytes have been predefined in the ASCII character set to be

used with software flow control. These bytes are named XOFF and XON, because they can stop and restart transmitting. The byte value of XOFF is 19, it can be simulated by pressing Ctrl-S on the keyboard. XON has the value 17 assigned which is equivalent to Ctrl-Q.

3. **Hardware:** Using hardware flow control implies that more lines must be present between the sender and the receiver, leading to a thicker and more expensive cable. Therefore, software flow control is a good alternative if it is not needed to gain maximum performance in communications.

- **Data Length:** You are allowed to choose 7-bit or 8-bit.
- **Stop Bits:** You are allowed to choose 1 or 2 as the stop bit.
- **Talk Only Mode:** Under the mode condition, the talk function can be activated. To activate/deactivate it, there are enable and disable for you to choose from.

4.2 Trigger Operations

In this section we will discuss the triggering system in M3530A. They provide a variety of trigger operations. You can select a trigger mode, a trigger source and different trigger settings for a specific measurement. The user's selection is stored in a volatile memory and the default settings will be restored after power-off. **Figure 4-25** shows the trigger operation in M3530A.
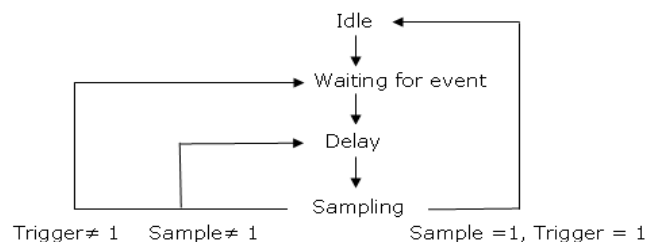
Trigger Operation Flow Chart

Figure 4-25

4.2.1 Trigger Modes

There are five trigger modes in M3530A : Immediate, External, Timer, Manual, and Internal triggering. You can specify the trigger mode for your measurement. The factory default is immediate triggering when the meter is power-on. The other setting around triggering is Source, Timer, Delay State, Delay, Out-Slope, In-Slope, Trigger Level, and Sample Count. And the following items describe what appears when you set them. You can find them through the procedures of **Figure-26**.

- **Source:** Immediate, External, Timer, Manual, and Internal are listed in order.
- **Timer:** HH:MM:SS.sss is the format. It will work when picking Timer as the source.
- **Delay State:** Manual, and Auto. The default is Auto.
- **Delay Time:** When the delay state is selected to Manual, the delay time from 0 to 3600 seconds is allowed to set.

- **Out/In-Slope:** Negative, and Positive. The default is Negative.
- **Trigger Level:** +0.000000 is the format. It can work with the source of Internal.
- **Sample Count:** Setting this will stop sampling when reaching the sample number which can be set as the buffer information at Section 4.4. By default, the M3530A take only one reading on each trigger.
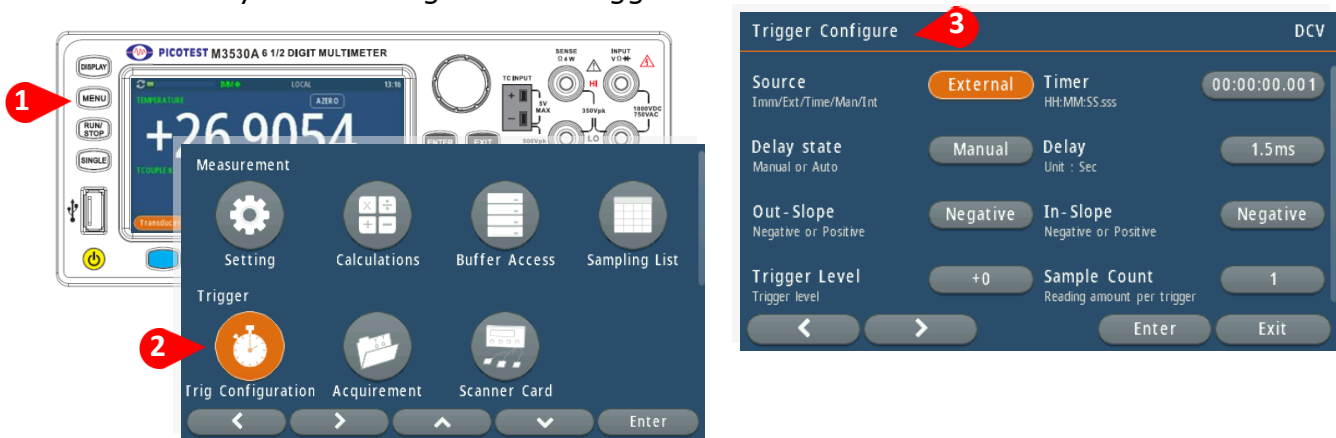
Trigger Configuration

Figure-26

A. Immediate Triggering Mode

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.

- Diagram:
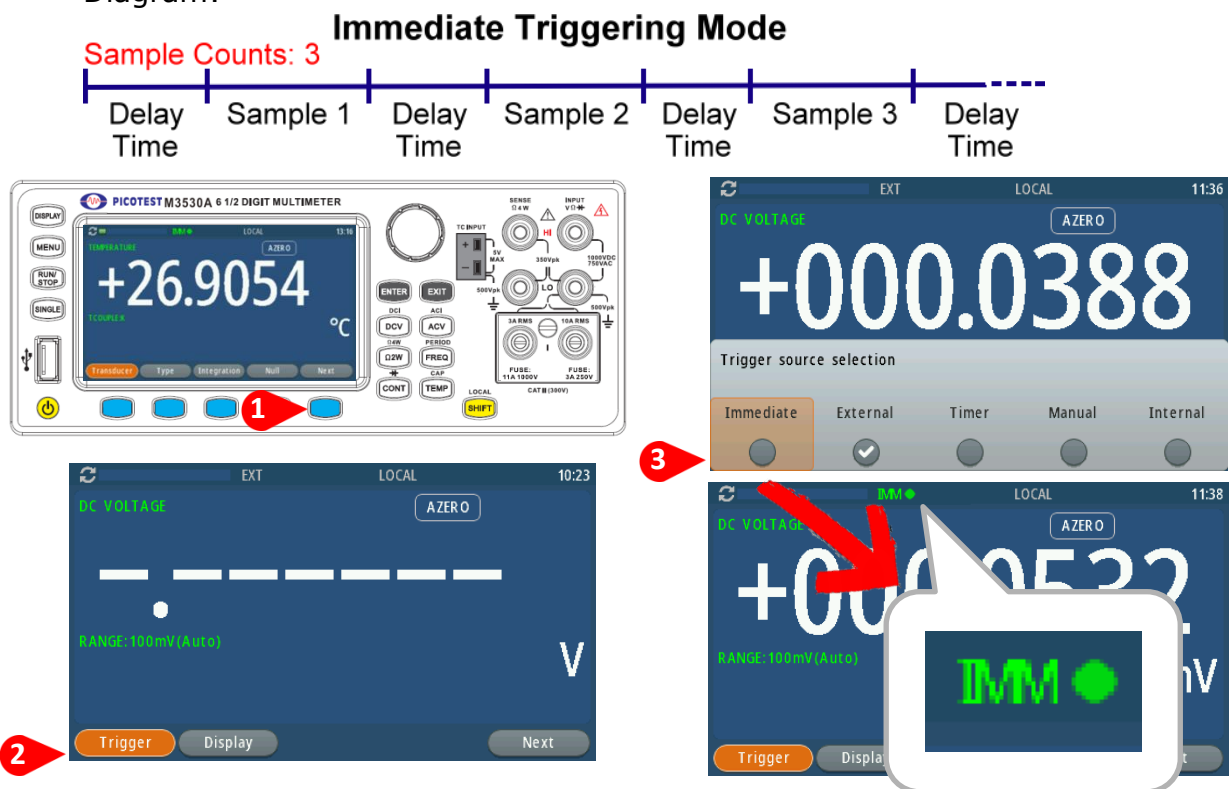
Trigger Source Selection

Figure-27

B. External Triggering Mode

This mode needs an external device to trigger M3530A . In detail, you apply a trigger pulse to the Ext TRIG (BNC) terminal on the rear panel. External hardware triggering is like using single trigger but the trigger source is an external hardware. When the multimeter receives a pulse from the trigger source, it takes one reading, or a specified number of readings. To set the external hardware trigger, press the soft-key under Trigger to select "External" to enable external hardware trigger (refer to **Figure-28**). The lit "EXT" on the upper middle display indicates the enabling of the external hardware trigger.

● Diagram:
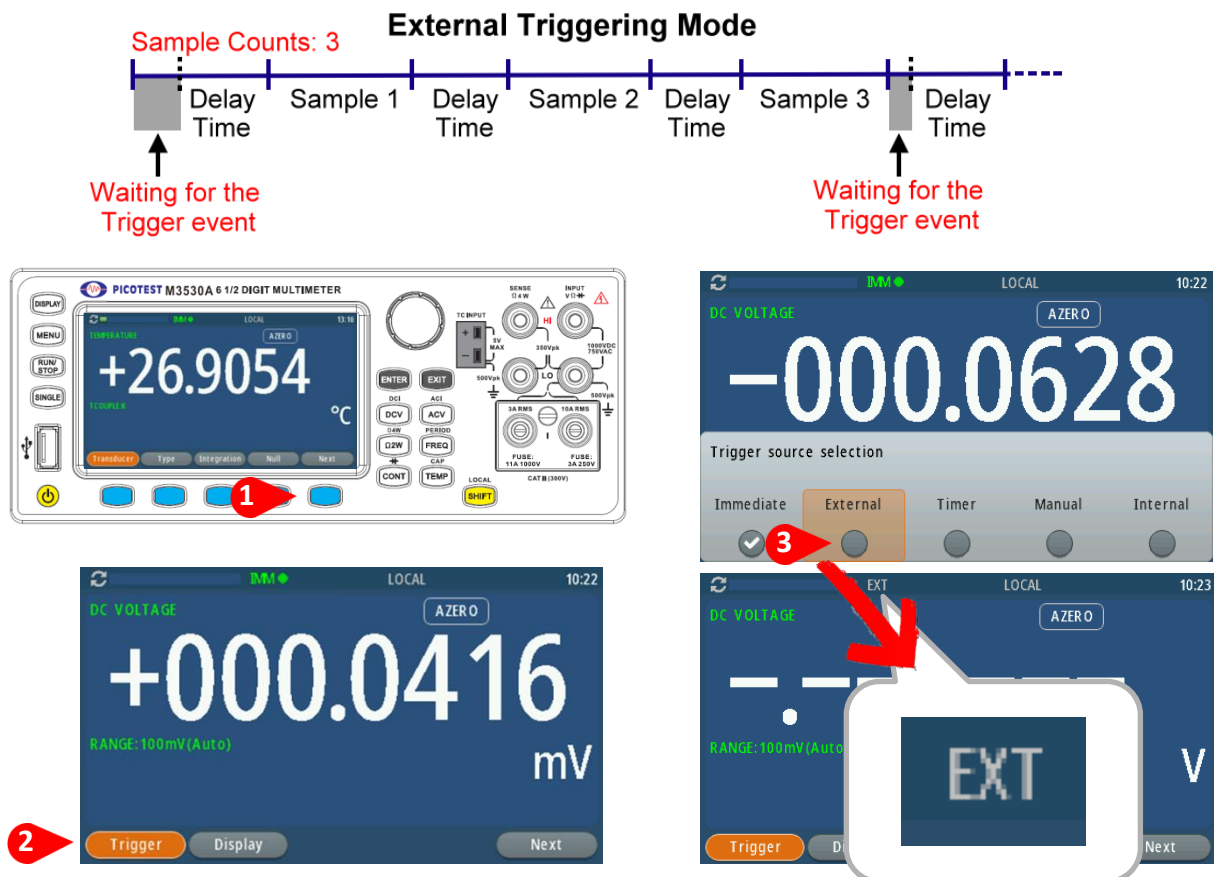
External Trigger Setup
Figure-28

● **The way to know External Trigger Terminal**

You can trigger the M3530A by using a low-true pulse input to the Ext Trig (external trigger) terminal located on the rear panel (Refer to **Figure-29**). And to use this terminal via the remote interface, you have to select the external trigger source by using the command, **TRIGer:SOURce EXTernal.**

Input

> 1 µs
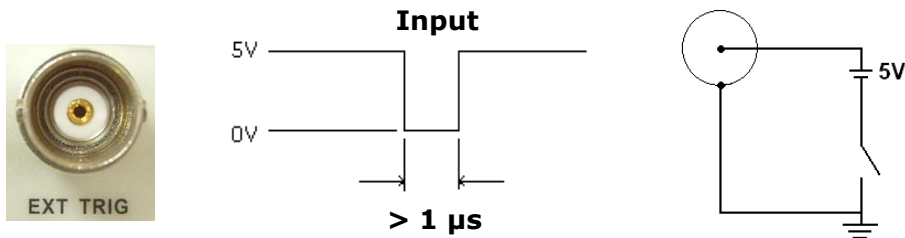
BNC Terminal & Input-Triggering Diagram
Figure-29

※ Note: An external trigger via a simple switch can be generated using the Ext Trig input.

- **The way to know VM COMP (Voltmeter Complete) Terminal**
  The real panel VM COMP terminal provides a low-true pulse output after finishing each measurement. The VM COMP shown below provides a standard hardware handshake sequence between measurement and switching devices.

Output
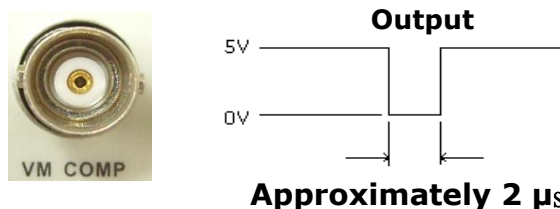
Approximately 2 µs
BNC Terminal & Output-Triggering Diagram
Figure-30

C. Timer Triggering Mode

The timer triggering mode is based on the due time to trigger once, and show on the display. The available setup scope is from 00:00:00.001 to 23:59:59.999. When the timer and sample count are set, it will circularly start to read the sample count after the timer is restart. The delay trigger setup will just affect the waiting time for the first-time reading. Setting up Integration more little, and calling off the Auto-range are also the factors to make measurement more effective, but the timer, delay time, and sample count are fixed during triggering.

- Diagram:

Timer Triggering Mode
Sample Counts: 3
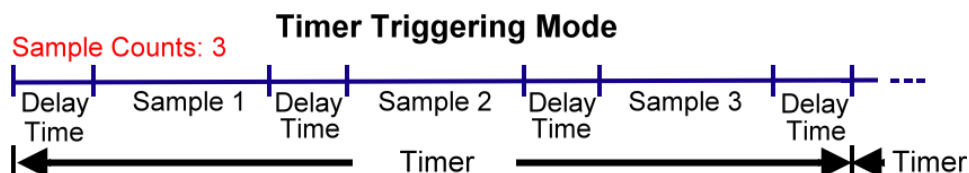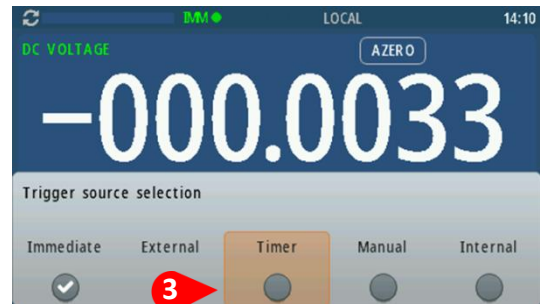
Timer Trigger Setup
Figure-31

D. Manual Triggering Mode

Under the manual triggering mode, the MAN in green on the upper side of the display is lit, the meter is ready for next trigger event. When the trigger grabs one signal, the meter signaling with MAN STOP in red on the upper side of the display is waiting for next trigger event. The manual trigger mode is only available through the front panel operations.

- Diagram:
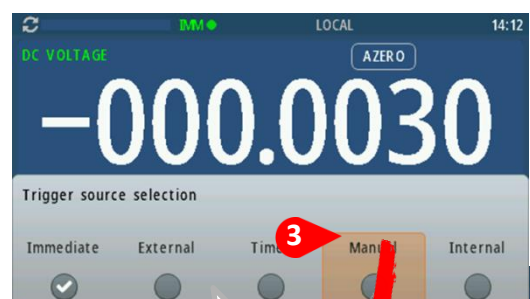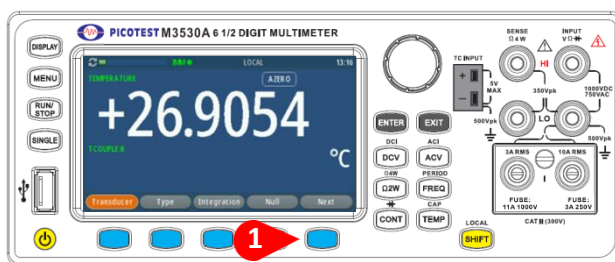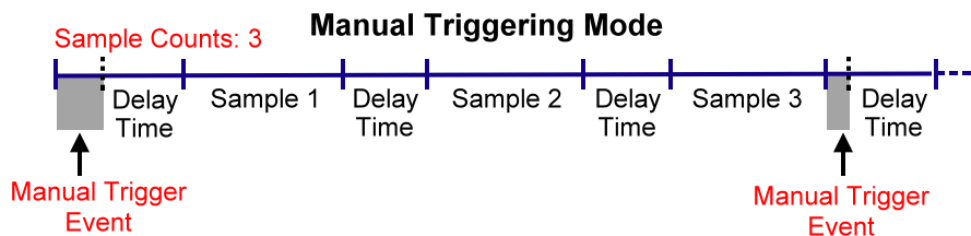
Manual Trigger Setup
Figure-32

In addition, the software trigger is similar to the manual triggering, but instead of using the "Manual" soft-key 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**

E. Internal Triggering Mode (Front Panel Operation only)

The internal triggering mode takes continuous readings at a fastest rate taking readings depends on the current setup. This function is only available through the front panel.

● Diagram:
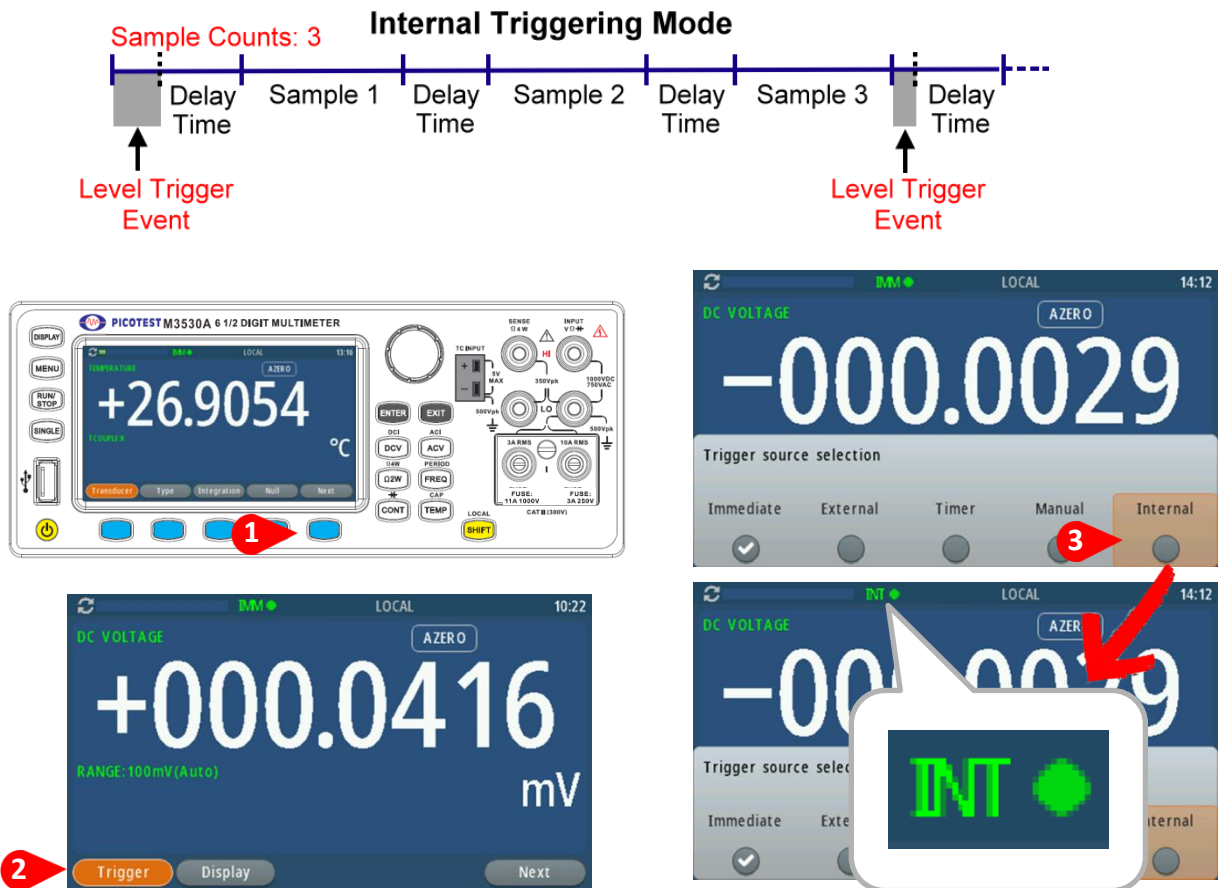
Internal Trigger Setup

Figure-33

※ Note: The delay time for automatic trigger delay is determined by the selection of measurement function, range, and the setup of integration time and AC filter speed. The following **Table 4-4** shows the default delay time for each measurement setup.

Table 4-4

Measurement Function	Setup	*Trigger Delay Time*
DCV/DCI	PLC >= 1	*2 ms*
	PLC < 1	*1.0 ms*
Ω2 and Ω4 (PLC >= 1)	100Ω ~ 100kΩ	*2 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 w/ Auto Trigger ON	*0 s*

4.3 Calculation Operations

The calculation operations under different function show up the available/unavailable setup items like the following **Table 4-5**. To access the setup, the procedures are as follows.

- Press the MENU button first.
- Press the selection of Calculations.
- Make sure the function is what you want. If the function isn't, directly choose the required function on the front panel using the button.

- The setup of Null, Filter, Math, Reading Hold, Limit, Statistics, and dB/dBm are provided for your requirement on measurement.

Calculation Setup

Figure-34

Table 4-5

Function \ Item	DCV/DCI	ACV/ACI	Ω2W/Ω4W	FREQ/PERIOD /RATIO	CONT/DIODE	TEMP/CAP
Null	√	√	√	√	√	√
Filter	√	√	√	√	√	√
Math	√	√	√	√	√	√
Reading Hold	√	√	√	√	√	√
Limit	√	√	√	√	√	√
Statistics	√	√	√	√	√	√
dB/dBm	√	√	X	X	X	X

4.3.1 Null

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

How to use null (relative) measurement

You can activate null from either the front panel operation or the command operation.

1. The Front Panel Operation

The null measurements can be used with any function except continuity and diode. To store the null test lead resistance, short the two test leads together and then press NULL soft-key. The new reading taken will replace the old value, if any, in the null register. Then, connect the two test leads to the input source. The value with null offset will show on the display. In addition, the null offset value can be found and adjusted manually by pressing the NULL soft-key for two seconds. Select the Null Value, and press the ENTER button/soft-key/knob to set a value or leave it to gain a value when any impedance is conducted, and then activate the NULL function like the **procedure1** below. The procedures are shown as **Figure 4-35**.

※Note: Press the NULL soft-key again to disable this feature. And the "NULL" indicator under activation/deactivation will show up/disappear on the display.
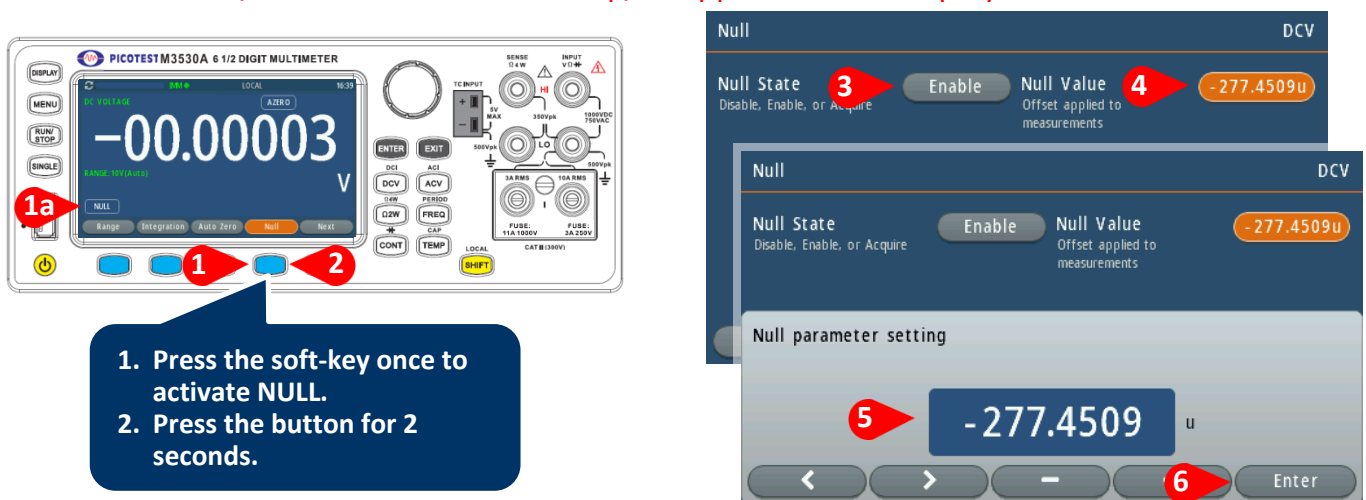
Figure 4-35

2. The Command 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**}

4.3.2 Filter

For more detailed information and operation, please check the **section 4.1.2**. The section instructs you how to access the Filter function, set the type and counts via the soft-key, the MENU, or the command operations.

4.3.3 Math

This section will introduce the mathematical operations in M3530A0 . There are three math operations: MX+B, Percent, and Reciprocal. They either store data for later use or perform mathematical operations on the readings.

※ Note1: These math operations are available to all measurement functions except continuity and diode testing.

※ Note2: The "MATH" indicator displays the state of a mathematical feature, and will be shown by enabling whichever math feature. Also, press the same buttons again for the enabled math feature will disable the same math feature.

To access the Math function, you can press the soft-key corresponding to the Math for two seconds. The Math state, and format will show up as **Figure 4-36**. After choosing a format you want from MX+B, Percent, or Reciprocal, the relative setup will appear.

1. Press the soft-key once to activate MATH.
2. Press the button for 2 seconds.
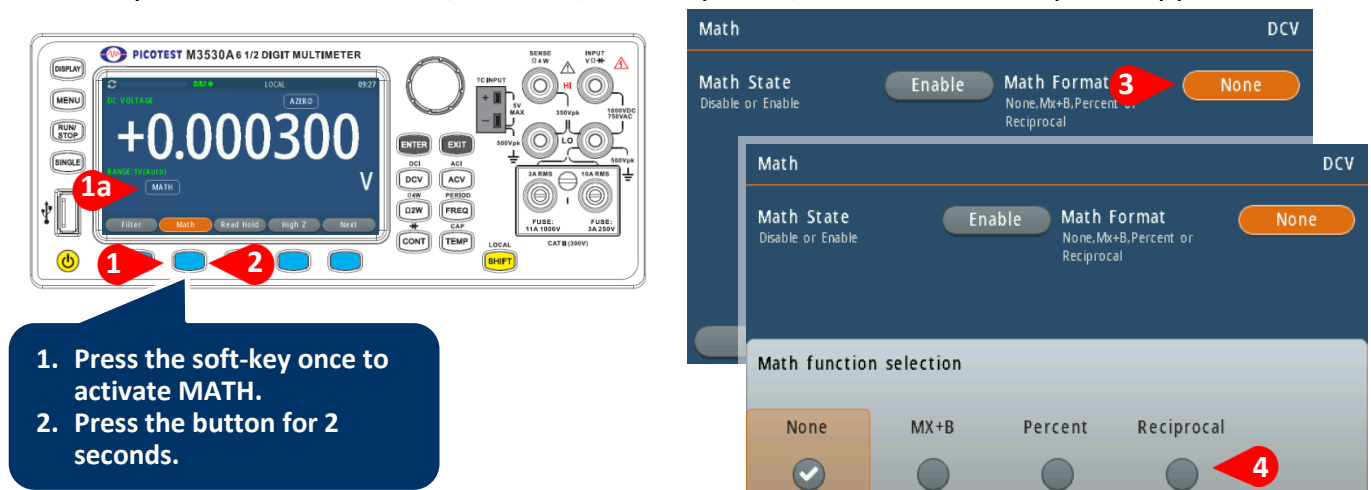
Math Function Enabling
Figure 4-36

4.3.3.1 MX+B

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   of measurements.

The values of the "M (Scaler)" and "B (Offset)" 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. You can either use front panel or remote interface to perform this function and set these two constant.

How to use MX+B function

You can use MX+B function from the front panel operation or the command operation. We provide two application exmples for your reference. If the input current source you want to measure exceeds the current specification, 3A/1, of the M3530A.

Then the DCV/ACV and MX+B functions would be helpful.

As to the MX+B setup, "M" stands for "1/R", "X" stands for "voltage measured by the DMM" and "B" stands for "Offset, 0".

Application:

(You're allowed to use it via the front panel operation for the single current measurement.):

For emple: Mr. Byden wants to measure a source, 1, through a M3530A DMM. However, the DMM's tolerance just can bear the maximum input current, 3A. What is he going to do next?

Please prepare a 0.1Ω current shunt, and obey the following procedures and illustrations as a big current measurement solution.

- Externally connect a current shunt "0.1Ω" in parallel connection to the INPUT HI & LO and a current source 1.
- Press the soft-key correspondent to the Math for two seconds.
- You need to choose the Math format to MX+B, and input the current shunt value "M = 1/0.1= 10Ω" and the Offset "B, ex: 0" value.
- Press the ENTER button to confirm the setup.
- The DMM's display will show a value +9.969XXXE+00. (This measurement also can be used with the PT-TOOL software. Please refer to the 5 ~ 7 procedures of the **Application 1**.)

※ Note1: If the input source exceeds the specification ACV: 750V / DCV: 1000V, the display will show OVLD.
※ Note2: Regarding the MX+B setup, the multimeter will either store data for later use or perform mathematical operations on the readings.

1. Press the soft-key once to activate MATH.
2. Press the button for 2 seconds.
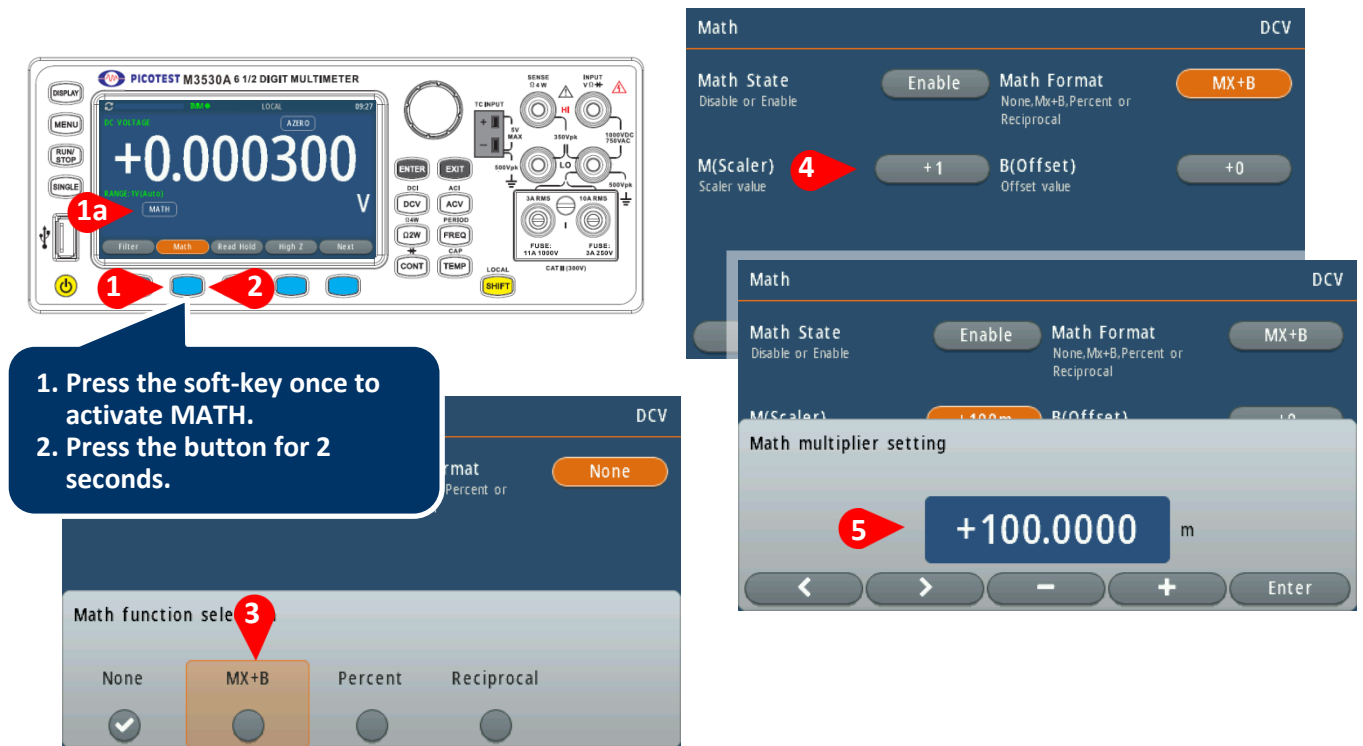
MX+B Function Enabling
Figure 4-37

4.3.3.2 Percent

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 command reset.

How to use the Percent function
There are two ways to make a percent measurement: Through the front panel operation or the command operation.

1. Front Panel Operation
To specify a target value, you need to configure Percent function through the following procedures as shown as **Figure 4-38**.

※ Note: Press the soft-key correspondent to the MATH to disable this function. The "MATH" indicator displays the state of a mathematical feature.

Percent Function Enabling
Figure 4-38

2. The Command 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]

4.3.3.3 Reciprocal

The measured values can be calculated in reciprocal. The format is 1/X. X stands for the measured value.

$$Reciprocal = \frac{1}{The\ Measured\ Value}$$

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

How to use the Percent function

There are two ways to make a reciprocal measurement: Through the front panel operation or the command operation.

1. Front Panel Operation

To specify a target value, you need to configure the reciprocal function through the following procedures as shown as **Figure 4-38**.

※ Note: Press the soft-key correspondent to the MATH to disable this function. The "MATH" indicator displays the state of a mathematical feature.

1. Press the soft-key once to activate MATH.
2. Press the button for 2 seconds.

Percent Function Enabling
Figure 4-38

4.3.4 Reading Hold

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

How to use/set the Reading Hold

This feature is only available from the front panel operations. To enable the reading hold, choose a measurement function you want, such as Ω2W for emple, and then press the soft-key correspondent to the Read Hold once. The HOLD indicator will show up on the display. To disable it, simply press the Read Hold through the correspondent soft-key. To set the reading hold, press the indicated soft-key for two second. The setup display will show up. The operations are shown as **Figure 4-39**. The same setup can be achieved through the path of MENU > CALCULATION > Reading Hold.

As for the setup, to activate the reading hold, you have to enable the state first. The window is used to set the reading hold's sensibility, and the higher percent is set, the more sensitive will be aroused with a beep. The count is allowed to set, and the stable

coming readings will be averaged. Enabling the Audible can drive a beep when gaining an averaged reading. To disable the reading hold function, press the Exit button for two seconds.

1. Front Panel Operation
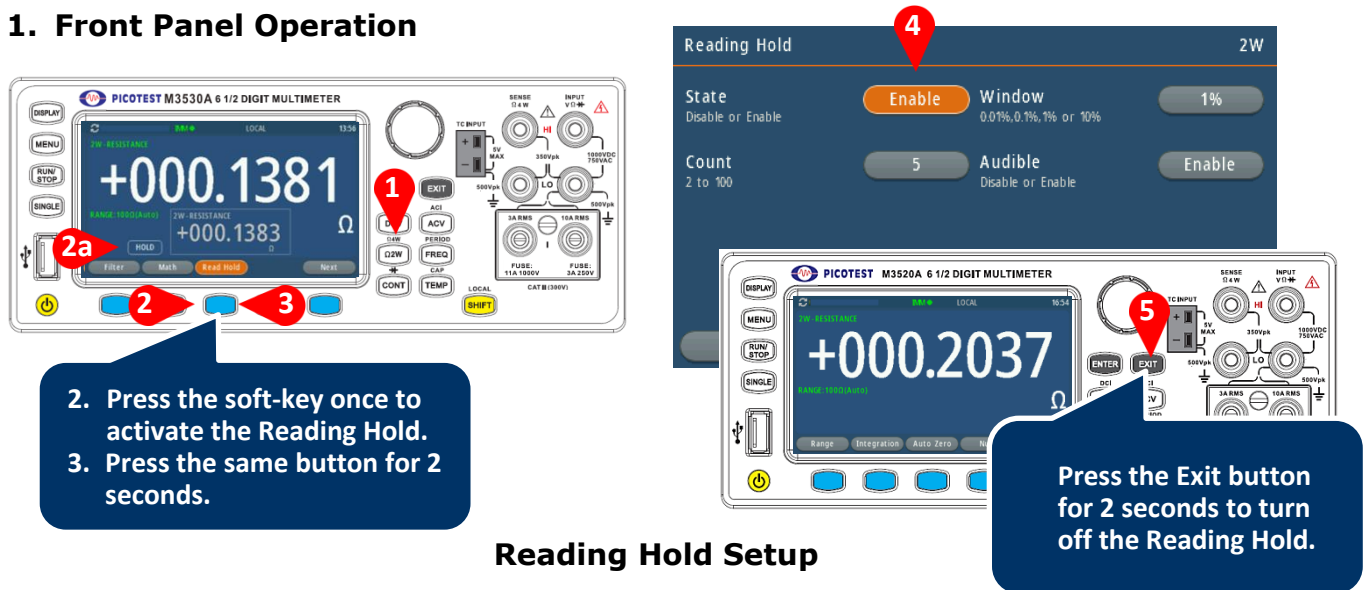
Reading Hold Setup
Figure 4-39

※Note: To look for the reading hold's place, the soft-key of Next should be used.

4.3.5 Limit

The limit testing operation allows you to adjust a maximal and a minimal limit values with beeps, and an "HI" or "LO" message will be shown when the reading exceeds the high or low limit respectively. You can set the limit values which stored in a volatile memory. The default values for both high and low limits are "0". This function is available to all except continuity and diode measurements.

※Note: You can also use this HI/LO measurement as a Pass/Fail application with the setup of TALK ONLY MODE, and finish the transmission through the Pin 1 and Pin 9 of the RS-232 (DB9).

How to set the limit

You can set the limit either through the front panel or the command operation.

1. Front Panel Operation
- Select a measurement function you need.
- Enter the limit setup through the path, MENU>CALCULATION>Limit
- Adjust the Limit state to "Enable". If turning it off, select "Disable".
- Enabling the Auto Clear, the limit under TALK ONLY MODE will be cleared with readings. This setup relates to the application of limit output via DB9.
- According to your condition, leave it a low & a high limit values. The defaults for the both are +0.

- Select the audible as Fail/Pass to alarm or leave it "None" to disable the audible.
- Press the Exit button twice to back to the measurement state.
- You will see the Limit indicator lit on the display. To disable the function, press the Exit button for two seconds. For more operation tips, please refer to **Figure 4-40**.
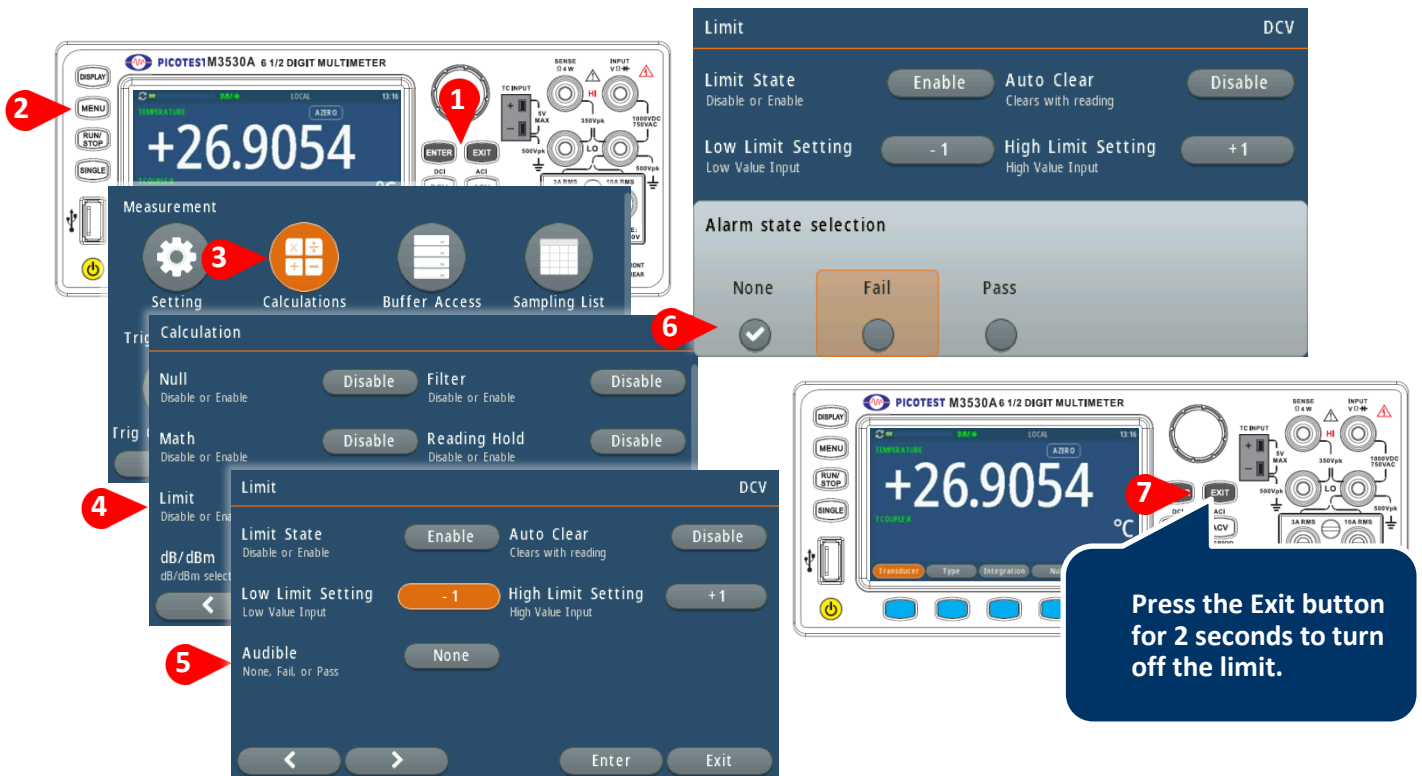
The Limit Setting
Figure 4-40

2. 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}

4.3.6 Statistics

When enabling the statistics function on the M3530A, it automatically calculates statistics on those measurements. To get accurate displayed statistics of AC measurements via the front panel operation, the default manual trigger delay must be activated via the soft-key of Trigger. For the trigger configuration, refer to the section **4.2.1**, and get to know it through the operations of **Figure-32**.

How to set the statistics
You can set the statistics either through the front panel or the command operation.

1. **Front Panel Operation**
   - Select a measurement function you need.
   - Enter the Statistics setup through the path, MENU>CALCULATION>Statistics
   - Adjust the Statistics state to "Enable". If turning it off, select "Disable".
   - Press the Exit button twice to back to the measurement state.
   - Press the soft-key correspondent to Display.
   - Press the soft-key correspondent to Statistics. The display will be changed to the Statistics mode as shown as **Figure 4-41**.
   - To turn off the statistics, press the Exit button for 2 seconds.
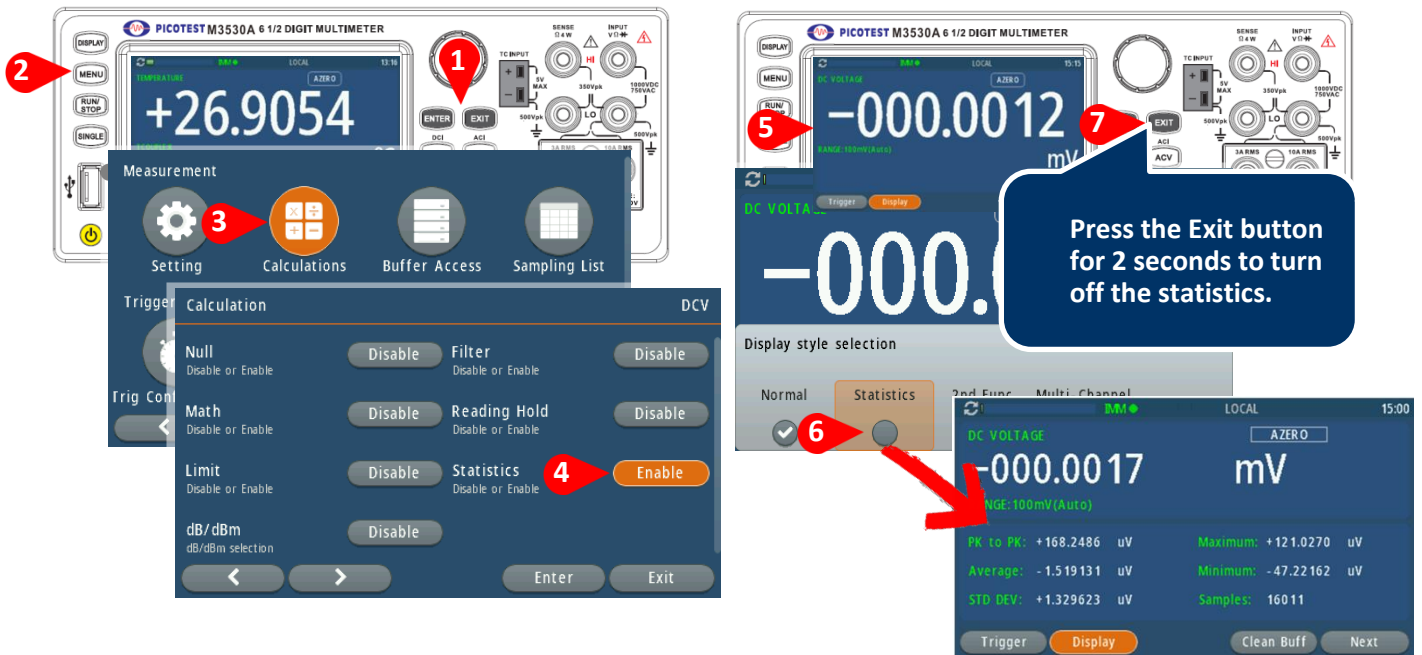
The Statistics Setting

Figure 4-41

4.3.7 dB/dBm

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:

$$dB = 20 \times \log(V_{in}/V_{ref}) \quad \text{or} \quad \textbf{dB = (Input signal in dBm) – (relative value in dBm)}$$

※ 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.

How to set the relative value

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

1. **Front Panel Operation**
   - Select a measurement function, DCV/ACV, you need.
   - Enter the dB/dBm setup through the path, MENU>CALCULATION>dB/dBm.
   - Adjust the dB/dBm state to "Enable". If turning it off, press the soft-key of dB/dBm again to the setup state. Press the Enter soft-key on the dB/dBm function, select "Disable". For more dB/dBm setup, you're allowed to leave a reference or gain a measure ref value once at the procedure 7 below.
   - Press the Exit button three times to back to the measurement state.

The dB/dBm Setting
Figure 4-42

4.4 Buffer Access Setup

You can store up 2600000 readings with time and date or 7500000 reading without time and date information measurements on the M3530A. Readings are stored in a first-in, first-out (FIFO) buffer; when reading memory is full, the oldest readings are lost as newer readings are taken.

In Local (front panel) mode, the instrument especially for M3530A collects readings, statistics, trend chart and histogram information in the background, so if you select any of those options, the data is ready for viewing.

In remote (SCPI commands) mode except M3530A, the instrument does not collect this information by default. Changing the instrument from local to remote does not clear any readings in memory, but changing the instrument from remote to local will clear any readings in memory. In general, you turn the reading of measurements on and off by

pressing the button of Run/Stop, as described above.

You can also take one reading or a specified number of readings by pressing the button of Single. To save readings, press the soft-key of Acquire and Save Readings. Then use the menu that appears to configure the location where you want to save the readings.

How to access the buffer
You can set the limit either through the front panel.

1. Front Panel Operation
- Select a measurement function you need.
- Enter the Buffer setup through the path, MENU>Buffer Access.
- The file name and the saved Date & Time will be listed. The information under the list showing the Buffer Size, File Mode, Samples, and Buffer Type presents the latest setup located at a specific file you pointed. Please refer to the following procedures as shown as **Figure 4-43**.
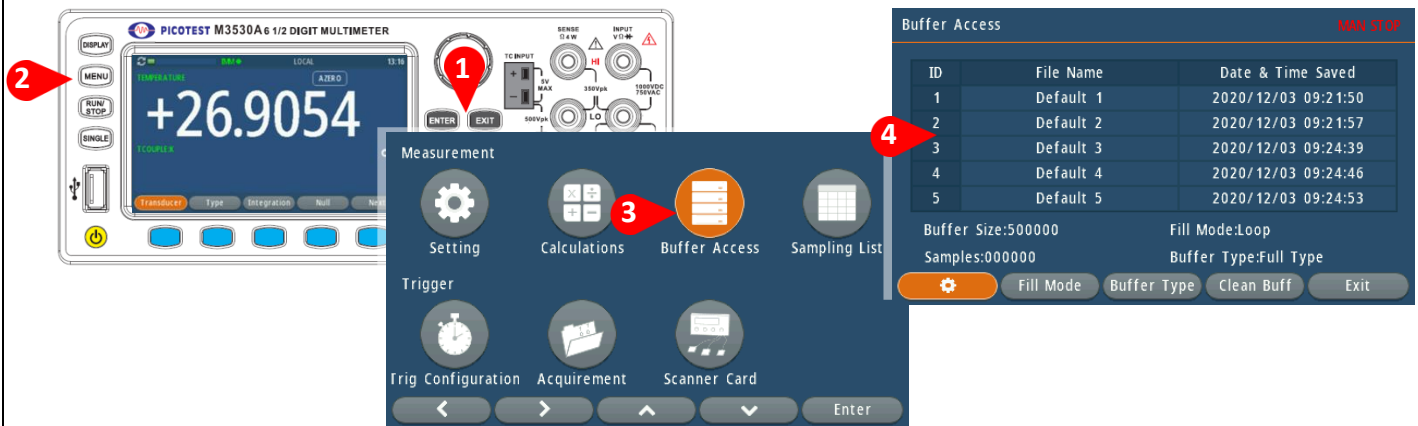
The Buffer Information
Figure 4-43

4.4.1 File Name Giving

To save data over your measurements, you have to file them with a specific name or leave it with a name that the system gives such as the Default 1 to 5. And data can be stored in 5 files at most.

How to set a file name
You can set a file name through the front panel.

1. Front Panel Operation
- Select a measurement function you need.
- Enter the Buffer setup through the path, MENU>Buffer Access.
- Press the soft-key of the step 4 to access the file name setup.

- Press Save at the Save to Internal, and it will show the saving location from Archive 1 to 5.
- Set Archive 1 as the saving location for emple.
- The keyboard will pop up for requiring a file name or leave it as the system name of Default 1 to 5.
- Move to OK to confirm the file name, and press the Enter.
- A confirming window pops up, and asks you if the former file can be overwritten.
- Press Yes to overwrite it or press No to skip the setup without saving.

The File Naming

Figure 4-44

4.4.2 Fill Mode

The fill mode relates to the Buffer Size. If you choose Loop, the buffer size will be filled up with data. When it's full, the existed data will be overwritten by new data cyclically under a first-in-and-first-out rule.

If choosing Once, the buffer size will be filled up with data. When it's full, your DMM will stop measuring.

How to set the fill mode
You can set the fill mode through the front panel.

1. **Front Panel Operation**
   - Select a measurement function you need.
   - Enter the Buffer setup through the path, MENU>Buffer Access.
   - Press the soft-key of the fill mode.
   - Select Loop or Once, and press the Enter to confirm.
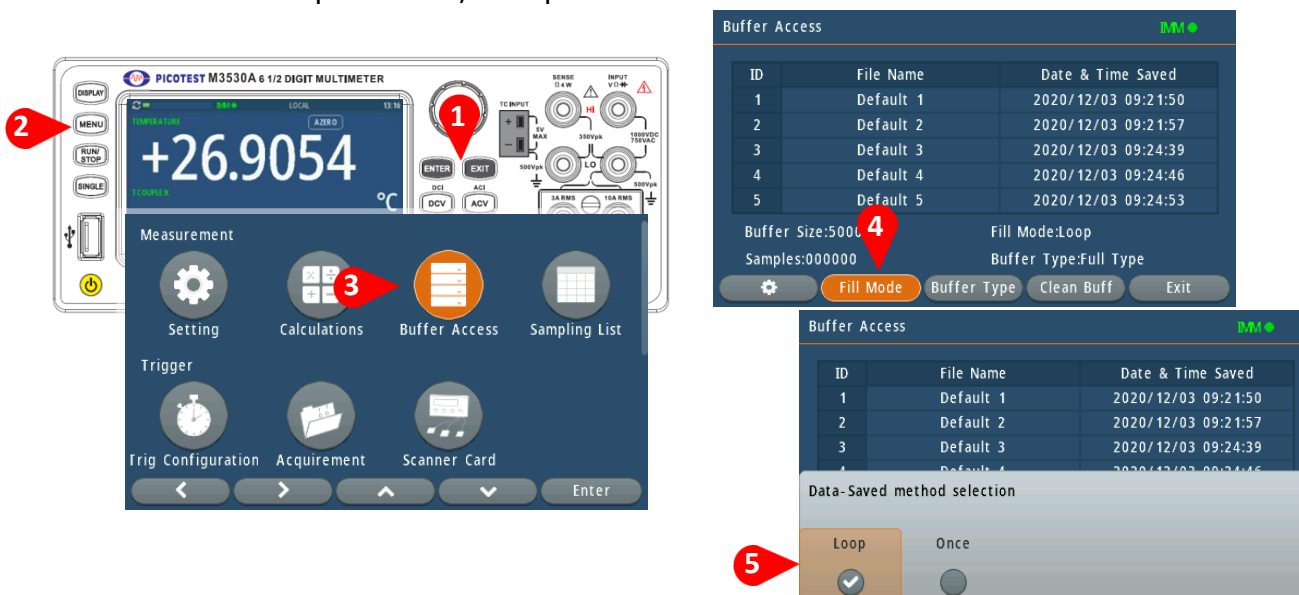
The Loop/Once Fill Mode
Figure 4-45

4.4.3 Buffer Type & Clean Buffer

Selecting a buffer type (in Full/Simple) determines whether the data information contains the saved Date & Time or not. If selecting the buffer type in Full, each datum will go with a date and time. If selecting the buffer type in Simple, each datum will go with a measured value without a date and time.

How to set the buffer type

You can set the buffer type through the front panel.

1. **Front Panel Operation**
   - Select a measurement function you need.
   - Enter the Buffer setup through the path, MENU>Buffer Access.
   - Press the soft-key of the buffer type.
   - Select the Full Type/Simple Type, and press the Enter to confirm.
   - To check the data under the full type/simple type, press the Exit button twice to back to the Menu state.
   - Access the Sampling List. If choosing the full type at the buffer access, the readings will be presented with date & time. If choosing the simple type, the data will go with readings only.
   - When the readings are needed to remove, press the soft-key of Clean Buff to erase them.
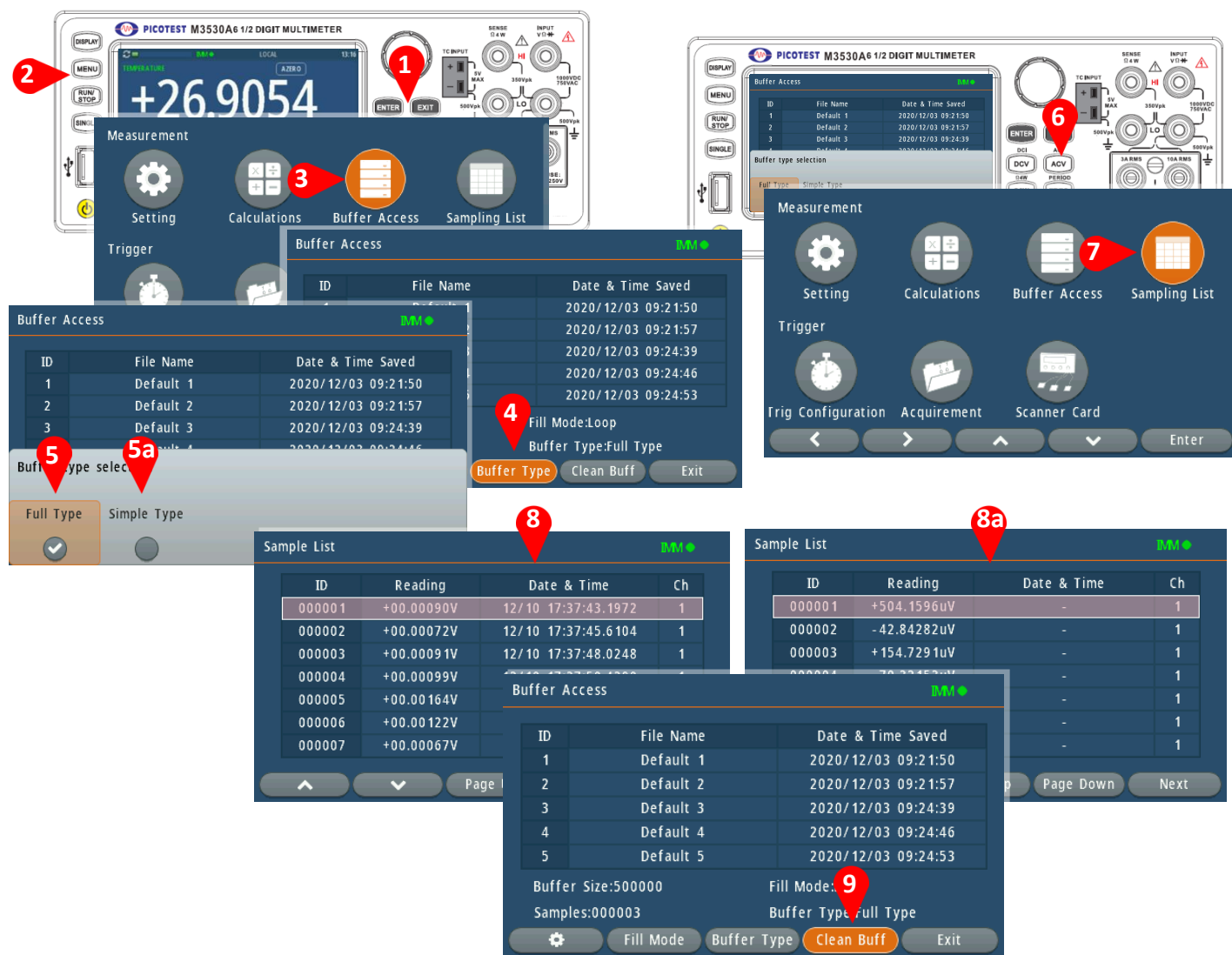
The Buffer Type Selection & Clean Buffer
Figure 4-46

4.5 Acquirement

M3530A can operate in the continuous, data logging, or digitize (for M3530A only) mode as described below.

Please note that when data-logging or digitizing to the non-volatile or the internal memory, if you access the instrument with commands through any interfaces such as USB/GPIB/RS-232/LAN, and return to local by pressing Local, the data will be cleared, excluding those which had been completely saved in the Archive or those saved in the USB hard drive.

4.5.1 Continuous Mode

Continuous mode is the default mode for M3530A. With the factory default setup, the DMM continuously makes DCV measurements with auto-range and auto-zero on, set Integration to 10 PLCs, etc. (see factory defaults for details). To select Continuous mode,

press MENU > Acquirement > Acquire > Continuous [Default].

This mode can be used with the DC voltage, DC current, AC voltage, AC current, 2-wire and 4-wire resistance, frequency, period, temperature, capacitance, and ratio measurement functions (diode and continuity are excluded).

How to set the continuous mode

You can set the Continuous Mode through the front panel.

1. **Front Panel Operation**
   - Select a measurement function you need.
   - Enter the Acquirement setup through the path, MENU>Acquirement.
   - Check the Acquire state whether it shows "Continuous".

The Continuous Mode
Figure 4-47

4.5.2 Data Log Mode

The Data Log mode is standard on the M3530A only, as is available only from the DMM's front panel. Data Log mode allows you to set up data logging into the instrument's nonvolatile memory, or to internal/external USB file(s), without programming, and without a connection to a computer. Once you have finished collecting data, you can view it through the front panel, or you can transfer the data to your computer. Data Log mode also allows you to log a specified number of readings, or readings acquired for a specified period of time, to instrument memory or to internal files. When the Data log destination is selected as Internal or USB, the data will be saved to the internal memory or an external memory hard drive.

To select Data Log mode, press MENU > Acquirement > Acquire > Data Log. You can then select the Sample Interval (time between measurements - for emple, 500ms), Duration as either an amount of Time or a number of Readings, whether to Start after a Delay or at

a specific Time of Day, and whether to Log to Memory or Log to File(s). After configuring the data logging parameters, press [Run/Stop] on the front panel. Data logging will begin following the specified Delay or at the specified Time of Day.

Data Log mode can be used with the DC voltage, DC current, AC voltage, AC current, 2-wire and 4-wire resistance, frequency, period, temperature, capacitance, and ratio measurement functions (diode and continuity are excluded). The maximum reading rate is 1000 readings/s and the maximum duration is 100 hours resulting in a maximum number of readings of 360,000,000 to file. The number of readings you can log to memory depends on the amount of instrument memory. With the MEM option, the limit is 2,000,000 readings; without the MEM option, the limit is 50,000 readings. By default, data logging implements auto trigger. The level and external trigger sources are not supported for data logging.

How to set the Data Log mode
You can set the Data Log Mode through the front panel.

1. **Front Panel Operation**
   - Select a measurement function such as DCV the connection with the DUT as shown as **Figure 4-48** below.
   - Enter the Acquirement setup through the path, MENU>Acquirement.
   - Change the Acquire state to "Data Log" via pressing the soft-keys or knob.
   - Specify the sample rate from 0.6Hz to 100kHz.
   - Or specify the sample type as interval for emple, 20ms.
   - Specify the duration type as (time or reading).
   - Specify the duration reading from 1 to 1000000000.
   - Specify the start type. When starting data logging with (delay or time), you can only use auto trigger (default) or single trigger (press the Single button on the front panel for data logging.
   - Specify the delay time in second (max./min. Setup: 10sec/10μsec)
   - Select whether to log data to the internal or USB file(s).
   - Specify a file location available from Archive 1 to 5.
   - Press the button of Run/Stop to start data log. Data logging starts when the specified delay has elapsed or the time of day occurs. Data logging will stop after the specified duration (time or number of readings) has occurred or after you press the Run/Stop button again.
   - To check the data saved in the Archive, please get into the buffer access and load the file from a specific Archive, and turn to the Sampling List to view the data (Refer to the **section 4.4.3**). To check the CSV data saved in the USB, please view the data via a computer.
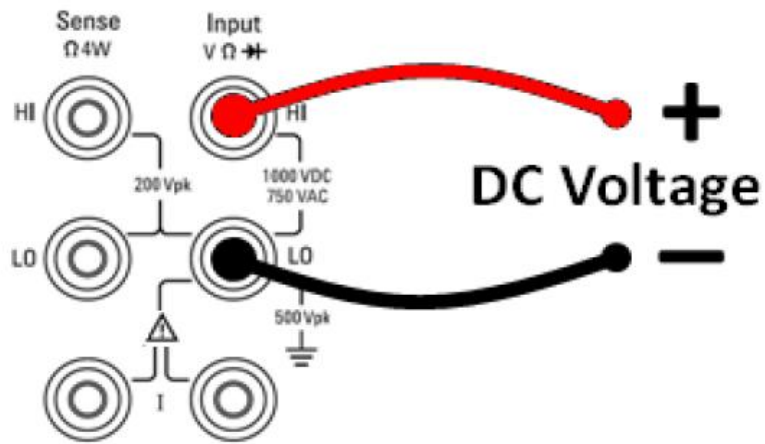
The Data Log Mode under DCV Connection

Figure 4-48
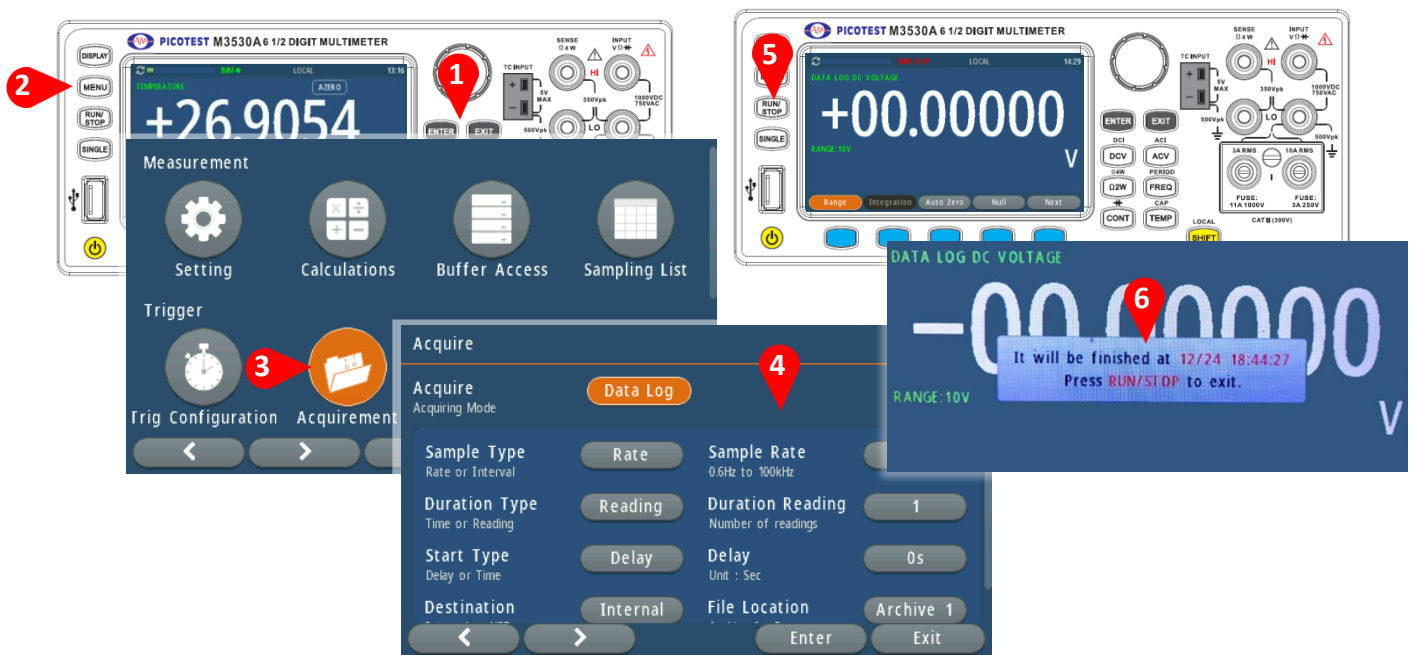
The Data Log Setup

Figure 4-49

4.5.3 Digitize Mode

Digitizing is the process of converting a continuous analog signal like a sine wave, into a of discrete readings as **Figure 4-50**.
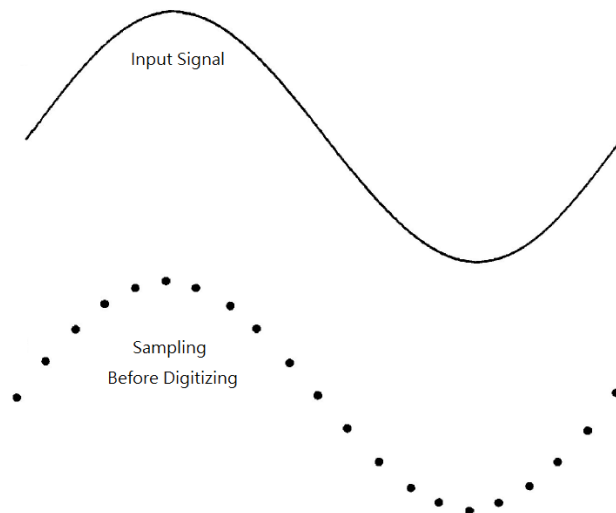
The Digitizing Process
Figure 4-50

The digitize mode applies under the DCV/DCI function only on the M3530A, and as is available only from the DMM's front panel. The digitized mode provides a front-panel user interface that allows you to quickly set up digitized measurements. Digitizing is the process of converting a continuous analog signal, such as a sine wave, into a of discrete samples (readings). The above figure shows the result of digitizing a sine wave. This chapter discusses the various ways to digitize signals.

Regarding the sampling rate, the Nyquist or Sampling Theorem states, "if a continuous, and bandwidth-limited signal contains no frequency components higher than F, the original signal can be recovered without distortion (aliasing) if it is sampled at a rate that is greater than 2F samples per second."

Practically, the sampling rate of multi-meters must be greater than twice the highest frequency component of the signal being measured. From the front panel you can select a sample rate in samples per second using the Sample Rate soft-key. You can also set the sample rate indirectly by specifying the sample interval (the time from the beginning of one sample to the beginning of the next sample) using the Sample Interval soft-key.
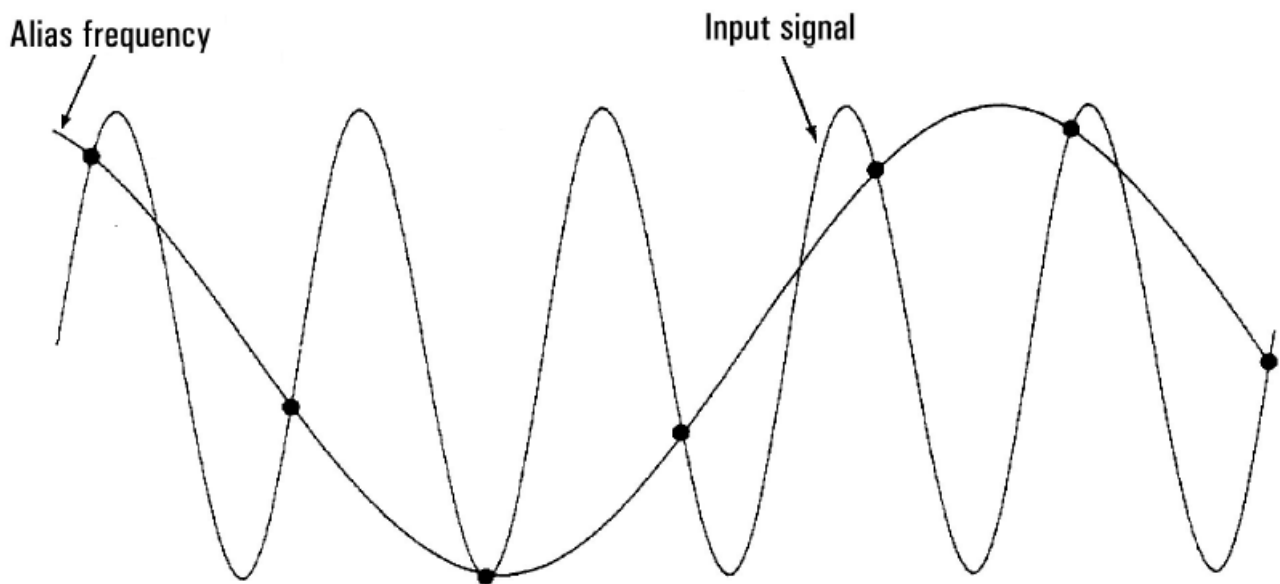
The Relationship between Alias Frequency and Input Signal
Figure 4-51

Figure 4-51 shows a sine wave sampled at a rate slightly less than 2F. As shown by the dashed line, the result is an alias frequency which is much different than the frequency of the signal being measured. Some digitizers have a built-in anti-aliasing low-pass filter with a sharp cutoff at a frequency equal to l/2 the digitizer's sampling rate. This limits the bandwidth of the input signal so that aliasing can't occur.

Due to a variable sample rate of the multi-meter for DCV digitizing, and preserving the upper bandwidth for high-frequency measurements, no anti-aliasing filter is provided in the multi-meter. If you are concerned about aliasing, you should add an external anti-aliasing filter.

In the case of digitizing, it's significant to begin sampling at some defined point on the input signal, for emple, when the signal crosses zero volts or when it reaches the midpoint of its positive or negative peak amplitude. The level triggering is used to specify when (with respect to voltage and slope) to begin sampling.

To select Digitize mode, press MENU > Acquirement > Acquire > Digitize. You can then select the Sample Type (Rate [Default]/Interval), set the Sample Rate as you wish, determine the Duration (Time/Reading [Default]), and leave your duration readings.

How to set the Digitize mode
You can set the Digitize Mode through the front panel.

1. Front Panel Operation
  ● Select a measurement function such as DCV the connection with the DUT as

shown as **Figure 4-48**.

- Enter the Acquirement setup through the path, MENU>Acquirement.
- Change the Acquire state to "Digitize" via pressing the soft-keys or knob.
- Specify the sample rate from 0.6Hz to 100kHz.
- Or specify the sample type as interval for emple, 20ms.
- Specify the duration type as (time or reading).
- Specify the duration reading from 1 to 1000000000.
- Digitizing will stop after the specified duration (time or number of readings) has occurred or after you press the Run/Stop button again.
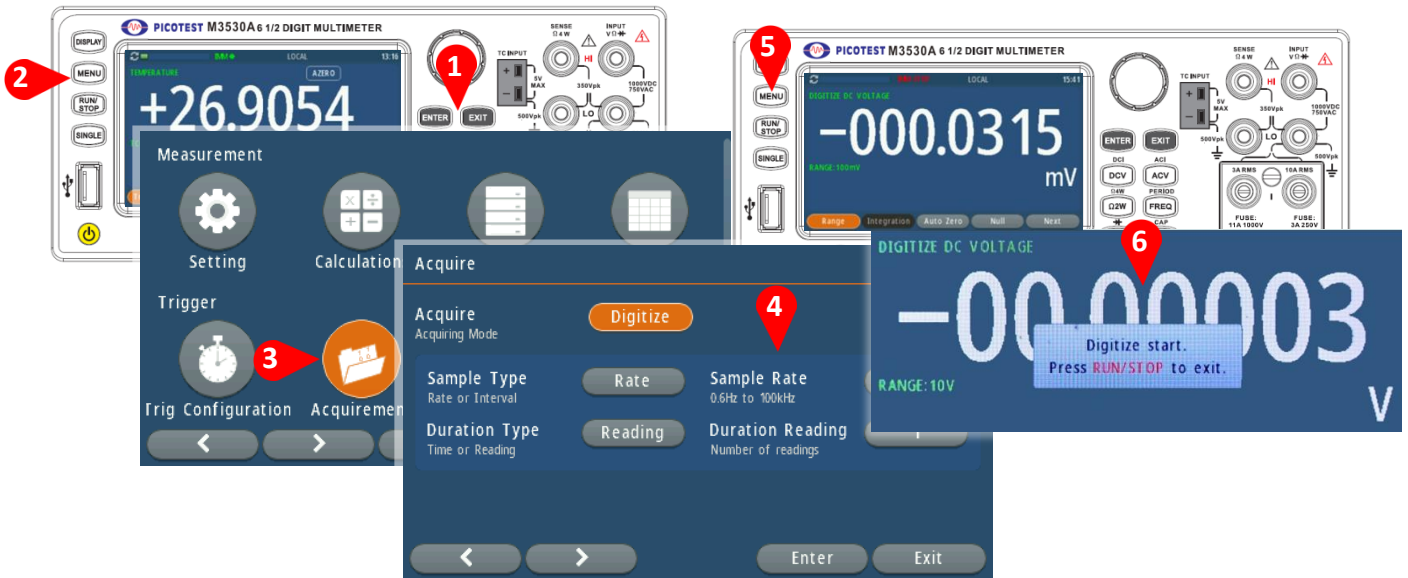
The Digitize Setup
Figure 4-52

4.6 Event Log

The event log provides the history records regarding the actions you make on M3530A . On the other hand, you're allowed to set the display warning, the display information, the log warning, the log information, the popups, the clean log, and the save-to-USB. Their descriptions going with the error codes are listed in the appendix 1.

How to check the Event Log
You can set the Event Log through the front panel.

1. Front Panel Operation
- Press the **MENU** button on the front panel.
- Select the **Event Log** from the menu pool. The System Event information will show up, such as event time, code and description.
- When the description is hidden due to the column length limitation, you are allowed to look into the complete content through operating the knob or the soft-keys.
- You are allowed to enable/disable the warning, to clean the log, or to save to USB

through the ⚙ selection to enter.

Event Log Checking
Figure 4-53

4.7 Save/Recall

M3530A have memories to save the setup state, such as Date & Time, Func(Range), PLC(Digit), Auto Zero, Null, Trig Source, Trig Delay, and Sample Count

How to save/recall the profile name from the memory
You can save and recall the state you want through either the front panel or the command operation.

**1. Front Panel Operation**

● Select a measurement function such as DCV the connection with the DUT as shown as **Figure 4-48**

● Press the **MENU** button on the front panel.

● Select **Save/Recall** from the menu pool. The saved profile name with the setup state will show up.

● Select one of the saved profile names.

● Press **Start-up** to recall the indicated former state, or press ⚙ to save the present to the new space or replace the former one. You're also allowed to delete or edit the profile name only.

● Referring to the following procedure 6 comparing with the procedure 4 as the emple, the state name had been changed to "B", and the profile 3 and 4 were removed.

※**Note:** The first profile named "Default" can't be renamed, edited, or deleted.

Setting up State Saving/Recalling
Figure 4-54

4.8 Calibration

Calibrating M3530A requires the equipment below and procedures which are authorized by Picotest Corp.

1. **Fluke 5730A:** calibrates DCV, DCI, ACV, ACI, 2-/4-Wire Ohm, and high frequency.
2. **Fluke 5725A:** calibrates the DCI & ACI at 3A & 10A.

How to operate the calibration

In addition to having the mentioned calibrators, and setting up the connections over them, to operate the calibration, please contact the manufacturer. The contact address is sales@picotest.com.tw . The unlock code after authorization will be given.
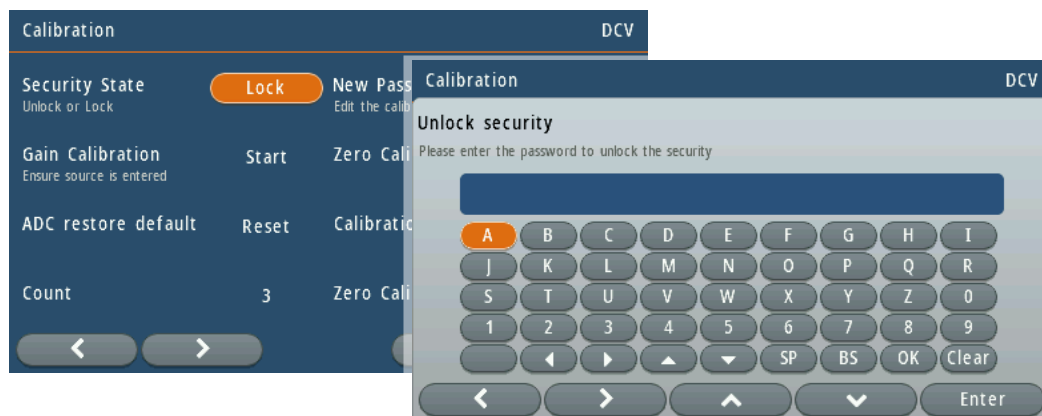
Calibration
Figure 4-55

Without the manufacturer approval, do not try to get into the calibration. Any invalid calibration to cause issues and require the manufacturer's assistance will be charged, even in the warranty.

4.9 System Settings

The system settings include the following items.

1. **Date & Time:** It shows the present time. If it doesn't match, select and adjust.
2. **Line Frequency:** It automatically shows the present detected line frequency.
3. **Audible Error:** When it's enabled, beeps will get up with any errors.
4. **Key Click Sound:** When it's enabled, any button pressed will go with a beep.
5. **Backlight Adjustment:** The level is from darker (1) to lighter (100).
6. **Backlight Saver:** To control the backlight saver, you're allowed to choose from Never, 1 min, 15 min, 1 hour, or 6 hours
7. **Display:** Enabling this item, you're allowed to view the state of display saver conducted.
8. **Language:** The operation system supports the language selection. You're allowed to choose from English, Russian, Japanese, Simplified Chinese, or Traditional Chinese.
9. **Reading Format:** If you would like to setup the E-Notation for readings, Prefix and Exponent are allowed to choose from.
10. **Self-Test:** Press "Start" to immediately run the self-test on your DMM.
11. **Compatible:** To simulate the compatible environment for 34461A and 34401A, you're allowed to setup here. Not to use it, the "Default" has to be selected.
12. **Power-Up State:** Before the system battery runs out, you can setup Power-Up State in advance. When you select "Keep", the DMM will be powered up directly as the AC line is input. When you select "Standby", you're required to press the power button to power up the DMM after the AC line is input. Once the battery runs out, and replace it with a new, your DMM will follow the above rule to power up.
13. **Welcome Screen:** Choosing "Default", the Picotest Welcome will show up for 2 seconds when powering up. Choosing "Skip", the DMM will skip the Welcome, and be immediately powered up.

How to setup the system
To setup the system is easy. Please follow the picture procedures to enter the setup.

System Settings
Figure 4-56
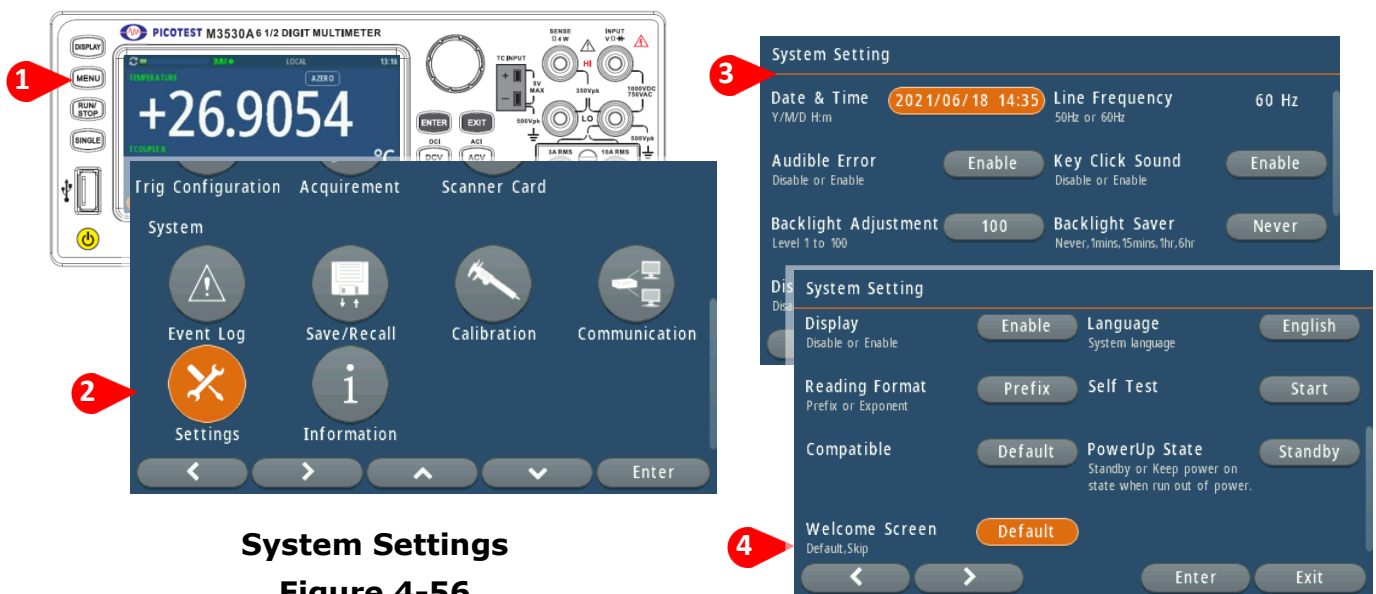
4.10 System Information

To upgrade the firmware, please get the latest one from the Picotest website
www.picotest.com.tw , and save it to your USB drive with the file name, M3530A, M3530A, or M3530A, which depends on your model number. Without an identical model number matching the file name, your upgrade will be failed.

Plug the USB drive to the host of your DMM, and follow the instructions and picture procedures below. Then your DMM will be upgraded. If you can't upgrade it, please write us with no hesitation sales@picotest.com.tw .

1. The USB flash drive needs to be formatted as FAT32. exFAT and NTFS are not supported.
2. After inserting the USB flash drive into the USB port, it will automatically create the following three folders:
    [root]:\[model name]\data
    [root]:\[model name]\firmware
    [root]:\[model name]\images
3. Please place the file download.pt into the firmware folder.
3. Files named datalog and sample are stored in the data folder when using USB storage. Pictures related to (long press) display are stored in the images folder.
4. The previously released file contains a document named Firmware Upgrade Manual.pdf, which provides detailed instructions on operating download.pt.

5 Remote Interface Operations

M3530A provides the remote interfaces, such as a built-in USB (USBTMC), and a built-in LAN (RJ-45), as well as supporting an optional GPIB (IEEE-488) or RS-232. Furthermore, this chapter lists the SCPI (Standard Commands for Programmable Instrument) commands available to control the multimeter. For the first time to use SCPI, you'd better to refer to Appendix B. for SCPI reference. Configuring the above interfaces, please refer to the section 4.1.9.

The following sections are about the knowhow or tips over the connections with the interfaces.

5.1 About DB-9 Cable of RS-232

To connect the M3530A to a computer or terminal, a proper interface cable is essential. Most computers and terminals belong to DTE (Data Terminal Equipment) devices including the DMM. You must apply a DTE-to-DTE interface cable, which is commonly called null-modem, modem-eliminator, or crossover cable (DB-9, Female to Female pin). The calbe pin diagram is shown below.
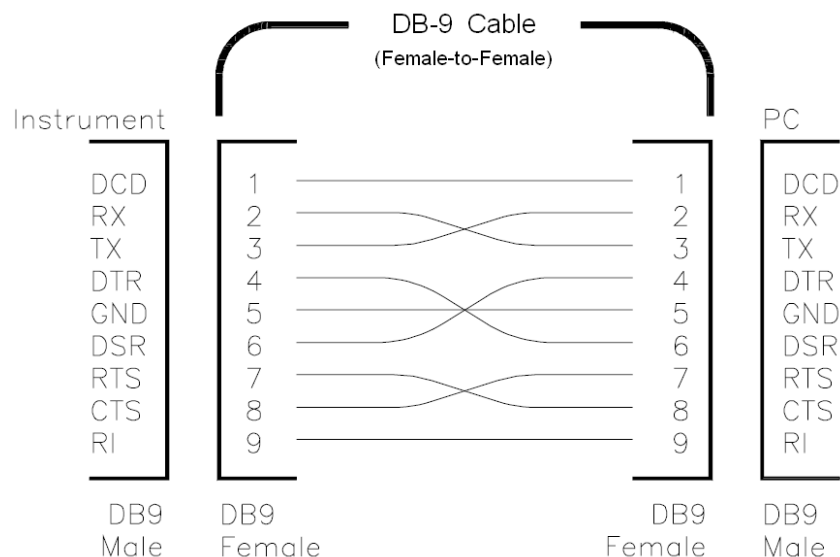
Troubleshooting about the RS-232
Generally, there is some troubleshooting when you meet problems on the RS-232 communication.

- Check that the M3530A and your computer are configured for the same baud rate, parity, and number of data bits. Confirm that your PC is set up for 1 start bit and 2 stop bits (The values are fixed on the DMM).

- Check that the interface cable and adapters have been connectd correctly, even the DB-9 Cable type, straight or crossover type.
- Check that the interface cable has been connected to the correct serial port on your PC (COM1, COM2, etc).

5.2 Pass/Fail Output via RS-232 Connector

The pass and fail signals are low true and indicate the Math Pass/Fail Limit Test result for the *next* reading to be output to the RS-232 interface. The signals are active low for approximately 2ms (± 100 μ sec) for each reading taken. **Figure 5-1** shows the connector. And **Table 5-1** shows the detailed connector information.

Pin 1: Pass Output
Pin 9: Fail Output

2 ms
minimum
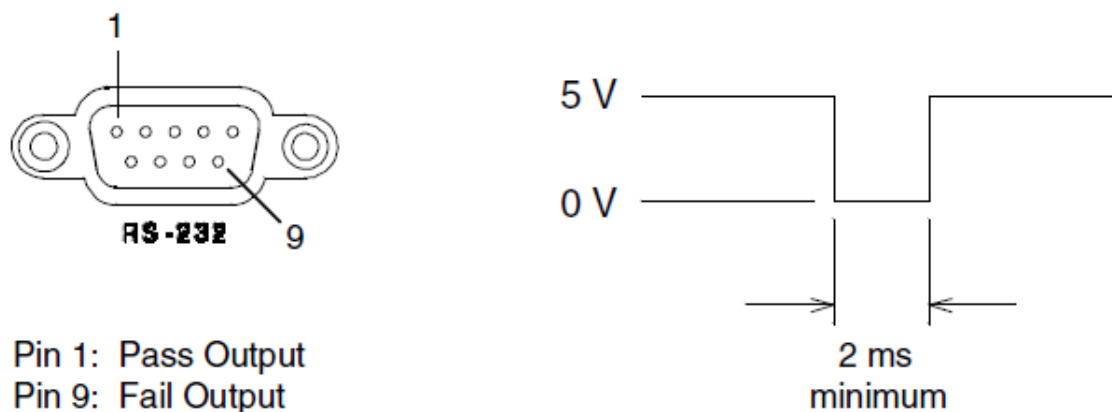
Figure 5-1

If you disable the RS-232 interface, the Pass/Fail output function will be ensabled automatically. Please follow the procedure below to enable/disable this function.

Procedure: MENU→Communication→RS-232→ENABLE/DISABLE

Table 5-1

Contact Number	Signal Name	Typical Wiring Assignment	Description
Pin 1	DCD	White	Limit Test Pass
Pin 9	RI	Green	Limit Test Fail

⚠️ Warning! You can't use the RS-232 interface to send SCPI commands if you want to enable the Pass/Fail signal output. You must use other interfaces for remote control.

5.3 Setting Up for Remote Interface via Software

You may use the M3530A application developed by PICOTEST to remotely control the multimeter. So far you can control the meter via LAN interface, and operate on its simulated web page app. This web page panel doesn't support SCPI command control.

For more LAN interface setup, the section 4.1.9 shows the way to connect, and setup.

5.4 Remote Interface Commands

You can instruct the multimeter to take measurements using the SCPI commands after the appropriate setup for your 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}

  CONTinuity?

  DIODe?

  TCOuple?

  TEMPerature?

The CONFigure Command

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

CONFigure:

    VOLTage:DC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
    VOLTage:DC:RATio {<range>|MIN|MAX|DEF },{<resolution>|MIN|MAX|DEF}
    VOLTage:AC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
    CURRent:DC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
    CURRent:AC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
    RESistance {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
    FRESistance {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
    FREQuency {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
    PERiod {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
    CONTinuity
    DIODe
    TCOuple
    TEMPerature

CONFigure?

The READ? Command

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

Using the READ? Command has a similar effect as using the INITiate command followed immediately by the FETCh? command, except readings are not buffered internally.

The INITiate and FETCh? Commands

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

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

The SENSe Commands

※ 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 "CONTinuity"

    FUNCtion "DIODe"

    FUNCtion "TCOuple"

    FUNCtion "TEMPerature"

    FUNCtion?

[SENSe:]

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

    VOLTage:DC:RANGe? [MINimum|MAXimum]

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

    VOLTage:AC:RANGe? [MINimum|MAXimum]

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

    CURRent:DC:RANGe? [MINimum|MAXimum]

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

    CURRent:AC:RANGe? [MINimum|MAXimum]

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

    RESistance:RANGe? [MINimum|MAXimum]

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

    FRESistance:RANGe? [MINimum|MAXimum]

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

    FREQuency:VOLTage:RANGe? [MINimum|MAXimum]

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

    PERiod:VOLTage:RANGe? [MINimum|MAXimum]

[SENSe:]

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

VOLTage:DC:RANGe:AUTO?

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

VOLTage:AC:RANGe:AUTO?

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

CURRent:DC:RANGeAUTO?

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

CURRent:AC:RANGe:AUTO?

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

RESistance:RANGe:AUTO?

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

FRESistance:RANGe:AUTO?

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

FREQuency:VOLTage:RANGe:AUTO?

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

PERiod:VOLTage:RANGe:AUTO?

[SENSe:]

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

VOLTage:DC:RESolution? [MINimum|MAXimum]

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

VOLTage:AC:RESolution? [MINimum|MAXimum]

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

CURRent:DC:RESolution? [MINimum|MAXimum]

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

CURRent:AC:RESolutioin? [MINimum|MAXimum]

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

RESistance:RESolution? [MINimum|MAXimum]

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

FRESistance:RESolution? [MINimum|MAXimum]

[SENSe:]

UNIT {*Cel*|Far|K}

UNIT?

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

TCOuple:TYPE?

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

TCOuple: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
{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|**1**|10|100|MINimum|MAXimum}

VOLTage:DC:NPLCycles? [MINimum|MAXimum]

CURRent:DC:NPLCycles
{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|**1**|10|100|MINimum|MAXimum}

CURRent:DC:NPLCycles? [MINimum|MAXimum]

RESistance:NPLCycles
{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|**1**|10|100|MINimum|MAXimum}

RESistance:NPLCycles? [MINimum|MAXimum]

FRESistance:NPLCycles
{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|**1**|10|100|MINimum|MAXimum}

FRESistance:NPLCycles? [MINimum|MAXimum]

[SENSe:]

FREQuency:APERture {0.001|0.01|**0.1**|1|MINimum|MAXimum}

PERiod:APERture {0.001|0.01|**0.1**|1|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?

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

GAIN:AUTO?

INPut:

IMPedance:AUTO {*OFF*|ON}

IMPedance: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

M350 provides some variant trigger operations. You can select a trigger mode, a trigger source and different trigger settings for a specific measurement. Refer to **Figure 4-8** for triggering system flow chart. Triggering from a remote interface is a multi-step sequence. You must first configure the mulitmeter by choosing the desired function, range and resolution. Specify the trigger source from which the multimeter will accept the trigger. The multimeter takes immediate internal trigger, a software trigger from a remote interface and external trigger from the rear panel. Then be sure that the multimeter is ready for a trigger (in the "wait-for-trigger" state).

The multimeter accepts a trigger only when it is in the "wait-for-trigger" state. When you have finished configuring the multimeter and have selected a trigger source, you need to

place the multimeter in the "wait-for-trigger" state so it will take the trigger and make the measurement. The INITiate, READ? and MEASure? commands all place the multimeter to the "wait-for-trigger" state.

Triggering Commands

INITiate

READ?

TRIGger:

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

SOURce?

TRIGger:

DELay {<seconds>|MINimum|MAXimum}

DELay? [MINimum|MAXimum]

TRIGger:

DELay:AUTO {OFF|ON}

DELay:AUTO?

SAMPle:

COUNt {<value>| MINimum|MAXimum }

COUNt? [MINmum|MAXimum]

TRIGger:

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

COUNt? [MINmum|MAXimum]

SYSTEM-RELATED Commands

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

FETCh?

READ?

DISPlay {OFF|*ON*}

DISPlay?

DISPlay:

TEXT <quoted string>

TEXT?

TEXT:CLEar

SYSTem:

BEEPer

BEEPer:STATe {OFF|*ON*}
BEEPer:STATe?

SYSTem:ERRor?
SYSTem:VERSion?
DATA:POINts?
SYSTEM:IDNSTR "MANUFACTURER,PRODUCT"

*RST
*IDN?
L0
L1

STATUS REPORTING Commands
SYSTem:ERRor?

STATus:
QUEStionable:ENABle <enable value>
QUEStionable:ENABle?
QUEStionable:EVENt?

STATus:PRESet

*CLS
*ESE <enable value>
*ESE?
*ESR?
*OPC
*OPC?
*PSC {0|*1*}
*PSC?
*SRE <enable value>
*SRE?
*STB?

Other Interface Commands
SYSTem:LOCal
SYSTem:REMote

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 you read all errors from the queue, the **ERROR** annunciator turns off. M3530A 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 are three categories of error types, such as the BASE, ERROR, and INFO execution errors". Here the list arrangement follows the rules of the negative numbers going first, and then the number size. If the errors you 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.

● **-108 Parameter not allowed**

More parameters were found than needed for the command.

● **-109 Missing parameter**

Not enough parameters were received for the command.

- **-113 Undefined header**

An invalid command was received.

- **-120 Numeric data error**

- **-121 Invalid character in number**

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

- **-128 Numeric data not allowed**

- **-138 Suffix not allowed**

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

- **-150 String data error**

- **-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.

- **-211 Trigger ignored**

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

- **-213 Trigger deadlock**

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

- **-215 Arm deadlock**

- **-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.

- **-230 Data corrupted or staled**

- **-315 Configuration memory lost**
The memory corruption is detected or the memory is lost due to the firmware revision change.

- **-350 Queue overflow**
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.

- **-411 Query timeout**

- **-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.

- **263 Device measuring**
The function isn't able to be executed while instrument is measuring.

- **511 RS-232 framing error**

- **512 RS-232 overrun error**

- **513 RS-232 parity error**

- **521 Input buffer overflow**

- **522 Output buffer overflow**

- **531 Insufficient memory**

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

- **532 Cannot achieve requested resolution**

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

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

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

- **541 Cannot use zero math reference**

The multimeter cannot use zero as math reference for PCT scaling function.

- **550 Command not allowed in local**

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

- **600 Self-test failed; Real Time Clock reset**

- **601 Self-test failed; keyboard processor not responding**

- **602 Self-test failed; unable to communication card**

- **603 Self-test failed; unable to sense line frequency**

- **604 Self-test failed; measurement processor not responding**

- **605 Self-test failed; calibration memory reading**

- **606 Self-test failed; FPGA unconfigured**

- **607 Self-test failed; FPGA bus**

- **608 Self-test failed; FPGA clock**

- **620 Self-test failed; Rundown too noisy**

- **621 Self-test failed; PGA x0.4 out of range**

- **622 Self-test failed; PGA x4 out of range**

- **623 Self-test failed; PGA x40 out of range**

- **624 Self-test failed; PGA x20 out of range**

- **625 Self-test failed; PGA x200 out of range**

- **626 Self-test failed; Buffer1 offset out of range**

- **627 Self-test failed; Buffer2 offset out of range**

- **628 Self-test failed; DC gain x0.4 failed**

- **629 Self-test failed; DC gain x4 failed**

- **630 Self-test failed; DC gain x40 failed**

- **631 Self-test failed; DC gain x200 failed**

- **632 Self-test failed; DC 1000V Zero failed**

- **633 Self-test failed; DC 10V Zero failed**

- **634 Self-test failed; Ohms 1uA source failed**

- **635 Self-test failed; DC high voltage attenuator 10M failed**

- **636 Self-test failed; DC high voltage attenuator 10M divider failed**

- **637 Self-test failed; DC Current 10uA sense failed**

- **638 Self-test failed; DC Current 1mA sense failed**

- **639 Self-test failed; DC Current 10mA sense failed**

- **640 Self-test failed; DC Current 1A sense failed**

- **641 Self-test failed; DC Current 1 sense failed**

- **642 Self-test failed; Ohms 10uA source failed**

- **643 Self-test failed; Ohms 100uA source failed**

- **644 Self-test failed; Ohms 1mA source failed**

- **645 Self-test failed; Internal 1nF failed**

- **646 Self-test failed; Internal 100nF failed**

- **647 Self-test failed; ACV 10V Range Rms Zero failed**

- **648 Self-test failed; ACV 10V Range Rms Pluse failed**

- **649 Self-test failed; ACV 1V Range Rms Pluse failed**

- **650 Self-test failed; ACV 100mV Range Rms Pluse failed**

- **651 Self Test ignored**

- **742 Calibration Error; security defeated**

- **743 Calibration Error; calibration memory secured**

- **744 Calibration Error; secure code provided invalid**

- **745 Calibration Error; provided value out of range**

- **746 Calibration Error; Measurement value out of range**

- **747 Calibration Error; Computed correction factor out of range**

- **748 Calibration Error; No cal for this function or range**

- **749 Calibration Error; setup is invalid**

- **750 Calibration Error; setup is out of order**

- **751 Calibration Error; Receive Data Timeout**

- **800 Nonvolatile memory write failure**

- **801 Volatile memory write failure**

- **821 Controller and measurement board model numbers do not match**

- **822 Controller and measurement board serial numbers do not match**

- **990 Channel slot number out of range**

- **993 Too much data**

- **1010 The null value is overloaded**

- **1060 check version (1)**

- **1100 The reading buffer is cleaned**

- **1101 The reading buffer is full**

- **1102 The simultaneity of the communication card is done**

- **1200 Front-End ADC Channel**

- **1201 Front-End ADC Communication**

- **1202 Front-End ADC Register**

- **1203 Front-End ADC Ready**

- **1204 Front-End ADC Crc**

- **1205 Front-End MCU Receive Data Lose**

- **1206 Front-End MCU Receive Data Check Id Err**

- **1207 Front-End MCU Receive Data CheckSum Err**

- **1208 Front-End MCU Receive Data Over Size**

- **1209 Front-End MCU Receive Data Timeout**

- **1210 Abort Init Err**

- **1211 Single Init Err**

- **1212 NSample Init Err**

- **1213 Read Buffer Init Err**

- **1214 Trig delay Err**

- **1215 Temp ref Err**

- **1216 Tc Offset Err**

- **1217 ADc Val Err**

- **1218 Cali No Data Err**

- **1219 Cali Data Chk Err**

- **1220 Cali No Factory Data Err**

- **1250 Not able to achieve requested resolution**

- **1251 Front-End Communication TimeOut**

- **1252 Front-End Communication**

- **1253 Front-End Communication ReSend**

- **1254 Front-End CMD Check**

- **1255 Front-End Data Checksum**

- **1256 Command not allowed in local**

- **1257 Front-End RTC sync**

- **1258 Front-End occurred reset**

- **1300 Firmware update success**

Appendix

This appendix contains the performance specifications of the M3530A . 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 M3530A unless noted otherwise.

A. Remote Interface Reference

A.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 emple, 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 emple, 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 emple, 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 emple, 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:

INPut:IMPedance:AUTO {OFF|ON}

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

DISPlay:TEXT <quoted string>

A.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

A.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 ACV measurements, the default is 5 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 an AC current measurement with the specified range and resolution. The reading is sent to the output buffer. For ACI measurements, the default is 5 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 10Hz and 300kHz. With no input signal applied, frequency measurements return "0".

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

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

MEASure:CONTinuity?

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

MEASure:DIODe?

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

MEASure:TEMPerature?

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

MEASure:TCOuple?

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

A.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 ACV measurements, the default is 5½ 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 ACI measurements, the default

is 5½ 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 10Hz and 300kHz. With no input signal applied, frequency measurements return "0".

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

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

CONFigure:CONTinuity

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

CONFigure:DIODe

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

CONFigure:TEMPerature

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

CONFigure:TCOuple

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

CONFigure?

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

A.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*	
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>*:RANGe {*<range>*|MINimum|MAXimum}

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

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

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

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

 Disable or enable autorange for the selected function.

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

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

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

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

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

Query the resolution for the selected function.

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

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

[SENSe:]UNIT?

Query units for temperature measurement.

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

Select thermocouple sensor type.

[SENSe:]TCOuple:TYPE?

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}

Set the RTD type.

[SENSe:]TEMPerature:RTD:TYPE?

Query the RTD type.

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

Set the R-Zero constant for the RTD type.

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

Query the R-Zero constant for the set RTD type.

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

Set the alpha constant.

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

Query the alpha constant for the set 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

{0.0008|0.0016|0.0024|0.008|0.02|0.06|0.2|*1*|10|100|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 {0.001|0.01|0.1|1|MINimum|MAXimum}

Set the gate time (or aperture time) for frequency function. Specify 10 ms (4.5 digits), 100 ms (default; 5.5 digits), or 1 second (6.5 digits).

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

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

[SENSe:]PERiod:APERture{0.001|0.01|0.1|1|MINimum|MAXimum}

Set the gate time (or aperture time) for period function. Specify 10 ms (4.5 digits), 100 ms (default; 5.5 digits), or 1 second (6.5 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).

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

Disable or enable the auto gain 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:]GAIN:AUTO?

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

INPut:IMPedance:AUTO{OFF|ON}

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

INPut:IMPedance:AUTO?

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

ROUTe:CLOSe <channel>

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

ROUTe:CLOSe?

Query channels which were closed.

ROUTe:OPEN

Open all channels.

A.6 The Math Operation Command

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

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

CALCulate:FUNCtion?

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

CALCulate:STATe {OFF|ON}

Disable or enable the selected math function.

CALCulate:STATe?

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

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

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

CALCulate:PERCent:TARGet? [MINimum|MAXimum]

Query the target value for percent math function.

CALCulate:AVERage:MINimum?

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

CALCulate:AVERage:MAXimum?

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

CALCulate:AVERage:AVERage?

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

CALCulate:AVERage:COUNt?

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

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

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

CALCulate:NULL:OFFSet?

Query the null value.

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

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

CALCulate:LIMit:LOWer?

Query the lower limit for the limit testing.

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

Set the upper limit for limit testing. You can set the value to any number from 0 to $\pm120\%$ of the highest range, for the present function.

CALCulate:LIMit:UPPer?

Query the upper limit for the limit testing.

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

Set the value of M.

CALCulate:MXB:MMFactor? [MINimum|MAXimum]

Query the value of M.

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

Set the value of B.

CALCulate:MXB:MBFactor? [MINimum|MAXimum]

Query the value of B.

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

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

CALCulate:DB:REFerence? [MINimum|MAXimum]

Query the dB relative value.

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

Set the dBm reference value. Choose from: 50 ~ 8000 ohms.

CALCulate:DBM:REFerence? [MINimum|MAXimium]

Query the dBm reference value.

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

Selects whether readings taken using the INITiate command are stored in the multimeter's internal memory (default) or not stored at all. In the default state (DATA:FEED RDG_STORE,"CALC"), up to 2000 readings are stored in memory when INITiate is executed. The MEASure? And CONFigure commands automatically select "CALC". With memory disabled (DATA:FEED RDG_STORE,""), readings taken using INITiate are not stored. This may be useful with the Min/Max operation since it allows you to determine an average of the readings without storing the individual values. An error will be generated if you attempt to transfer readings to the output buffer using the FETCh? command.

DATA:FEED?

Query the reading memory state. Return "CALC" or "".

A.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.

A.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.

A.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, you 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 emple: *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, you have to write a decimal value corresponding to the binary-weighted sum of the bits in the register by your demands.

Binary Weights

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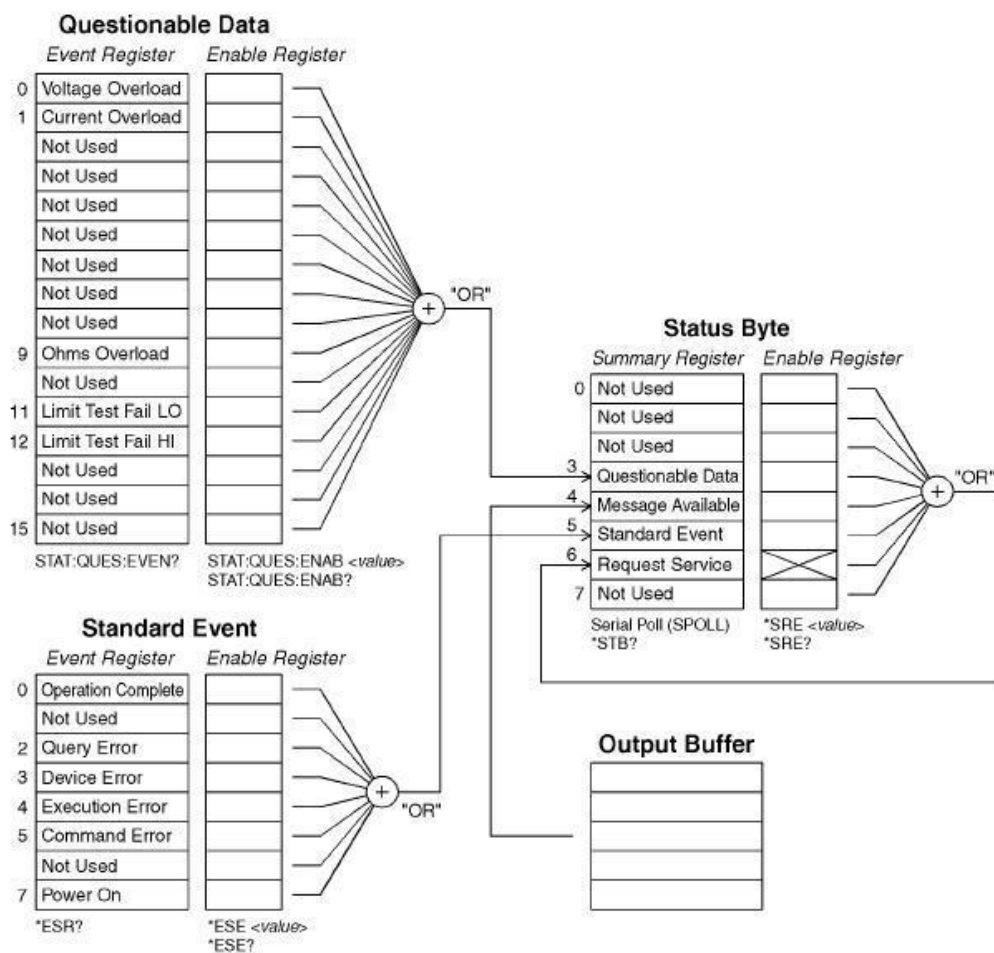
About the Status Byte

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 you have to note.

The following conditions will clear the summary register.
● You 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.
● You turn on the power, and have set the DMM previously by using the *PSC 1 command.
● You 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 your 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 you 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
- Send a bus device clear message.
- Clear the event register by using the *CLS command.
- Set the *ESE and *SRE commands to enable masks.
- Send the *OPC? command and enter the result to enable synchronization.
- Enable the bus controller's IEEE-488 SRQ interrupt.

Procedures to Determine When a Command Sequence is Completed.
- Clear the DMM's output buffer by sending a device clear message.
- Clear the event registers by using *CLS command.
- Enable "operation complete" by using the *ESE 1 command.
- Send the *OPC? command and enter the result to enable synchronization.
- When bit 5 is set in the status byte summary register, please use a serial poll to check. Then you 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 you 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 you 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, you 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.
● You send a *CLS command.
● You query the event register by using the *ESR? command.

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

※ Note: When the DMM is powered on, the standard event enable register won't be cleared if you have set the DMM previously by using *PSC 0.

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, you 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.
- You execute a *CLS command.
- You query the event register by using STATus:QUEStionable:EVENt?.

The following conditions will clear the questionable data enable register.
- You turn on the power without using *PSC command.
- You execute the STATus:PRESet command.
- You execute the STATus:QUEStionable:ENABle 0 command.

A.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

Set 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.

A.11 SCPI Compliance Information

This section encloses a list of commands that are device-specific to the M350. 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

INPut:

IMPedance:AUTO {OFF|ON}

IMPedance:AUTO?

A.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

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.

DECLARATION OF CONFORMITY

Conformity with the following European Directives:

The product herein conforms with the requirements of the Low Voltage Directive 2014/35/EU, the EMC Directive 2014/30/EU and is also found in compliance with council RoHS directive -2015/863/EU. It goes with the CE and UKCA 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: M3530A

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

EMC:

EN61326-1:2021, EN61326-2-1:2021

    EMI:

    CISPR 11: 2015 +A1:2016 +A2:2019, Class A

    EN 61000-3-2:2019+A1:2021, EN 61000-3-3:2013+A1:2019+A2:2021+AC:2022

    EMS:

    IEC 61000-4-2:2008, IEC 61000-4-3:2020, IEC 61000-4-4:2012,

    IEC 61000-4-5:2014 +A1:2017, IEC 61000-4-6:2023, IEC 61000-4-8:2009

    IEC 61000-4-11:2020

Safety:

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

IEC61010-2-030:2010/EN61010-2-030:2010(1st Edition) used in conjunction with EN 61010-1:2010,

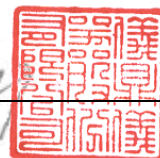IEC 61010-1: 2010 (Third Edition)

UL 61010-1, 3rd Edition

Environment Quality:

CERTIFICATE OF COMPLIANCE TO RoHS (EN IEC 63000:2018) SUBSTANCE RESTRICTIONS

25th December of 2024
Date

Mr. Hawk Shang
General Manager

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