KUSAM-MECO®

# User Manual

## KM 3700

## Digital Multimeter

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# Chapter 1 Safety and General Information

## Safety Symbols

These safety symbols may appear in this manual or on the KM 3700.

| | |
|---|---|
|  | **WARNING**<br>Identifies conditions and/or practices that could result in injury or loss of life. |
|  | **CAUTION**<br>Identifies conditions and/or practices that could result in damage to the KM 3700 or to other property. |
|  | Danger high voltage |
|  | Protective earth terminal |
|  | Ground terminal |
|  | Frame or chassis terminal |
|  | The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives. |
|  | Contains one or more of the 6 hazardous substances above the maximum concentration value (MCV), 40 Year EPUP. |
|  | Do not dispose electronic equipment as unsorted municipal waste. Please use a separate collection facility or contact the supplier from which this instrument was purchased. |
| **CAT II (300** | IEC Measurement Category II. Inputs may be connected to AC mains power (up to300 VAC) under Category II overvoltage conditions. |

# Safety Instructions

## General

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

⚠ **WARNING**

- Do not replace the detachable mains supply cords by inadequately rated cords. Use only the specified power cord for the country of use or one with equivalent ratings.

- Connect the protective grounding conductor of the AC power cord to an earth ground, to avoid electrical shock. It is prohibited to disconnect the earthed protective connection inside or outside the instrument.

- No part of the product may be modified or rebuilt, and the housing must not be opened.

- To avoid risk of fire, replace the AC main power line fuse only with the specified type and rating. Disconnect the power cord and all measurement terminals before fuse replacement. Make sure the correct type of fuse is installed before powering up.

- The measuring circuit is equipped with two fuses for overcurrent protection. The user may replace one of the fuses on the rear panel of the instrument. An additional fuse is built into the instrument; however, this is not intended to be replaced by the user.

- If a safe operation can no longer be assumed, the instrument must be put out of operation and secured against unintended operation. Safe operation can no longer be assumed if:
  - the product shows visible damage,
  - does not function any longer and
  - the unit was stored under unfavorable conditions for a long period of time or
  - it has been subjected to considerable stress in transit.

- Do not discharge static electricity to the instrument.
- Measurements are not permitted in damp rooms or outdoors, nor under adverse environmental conditions.
  Adverse environmental conditions are:
  - Wet conditions or high air humidity,
  - Dust and flammable gases, vapors or solvents,
  - Thunderstorms or similar conditions such as strong electrostatic fields, etc.

- Do not change the position of the Front/Rear switch on the front panel while signals are present on either the front or rear set of terminals. Switching while current or high voltage is present may cause instrument damage and lead to the risk of electric shock.

- Avoid severe impact or rough handling can lead to damaging the instrument.
- Use only mating connectors, not bare wires, for the terminals.
- Do not disassemble the instrument unless you are qualified as service personnel.
-

⚠ **CAUTION**

- When subjected to transient radiated and/or conducted electromagnetic phenomena, the product may have temporary loss of function or performance which is self-recovering. Recovery may take longer than 10 seconds. When subjected to continuously present electromagnetic phenomena, some degradation of performance may occur.

- The allowed operating temperature ranges from +0 °C to +50 °C (pollution category 2). The maximum relative humidity (without condensation) is 80% at 40 °C. During storage and transport, the temperature must be between –40 °C and +70 °C. The maximum operating altitude for the instrument is 2000m.

- Never switch the instrument on immediately after having taken it from a cold to a warm environment. The condensation that forms might destroy your instrument. Allow the instrument to reach room temperature before switching it on.

- Prior to operating the instrument, please check if the available mains voltage (110V or 220V ±10%, 50-60Hz) corresponds to the value indicated on the voltage selector of the instrument. If this is not the case, the main voltage will need to be switched. The voltage selector is located on the back of the instrument.

## Product Regulatory and Compliance

DMM complies with safety and EMC standard EN 61326:1997 +A1+A2+A3.

## Measurement Limits

The KM 3700 DMM provides a protective circuitry to prevent damage to the instrument and to protect against a possible electric shock. The maximum value for the instrument must not be exceeded. The protection limits are listed on the front and rear panel to ensure the safe operation of the instrument.

### Input Terminal Measurement Limits

Measurement Limits are defined for the input terminals:

**Main input (HI and LO) terminals.** The HI and LO input terminals are used for voltage, resistance, frequency (period), capacitance, and diode test measurements. Two measurement limits are defined for these terminals:

**HI to LO measurement limit.**
HI to LO (input terminals) max. input voltage: 1000Vpk (DC) or 750$V_{RMS}$ (AC)

**LO to Ground measurement limit.**
The LO input terminal can safely "float" a maximum of 500 Vpk relative to ground, where ground is defined as the Protective Earth Conductor in the AC mains power cord connected to the instrument.
Max. voltage between LO and Ground: 1500Vpk
Max. voltage between LO and Ground: 500Vpk

**Current Input Terminal.**
Max. input current: 3 A or 10 A (DC or AC).

NOTE

*The current input terminals will always be at approximately the same voltage as the LO terminal, unless a current protection fuse is open.*

**Sense Terminal Measurement Limits**
The HI and LO sense terminals are used for DCV ratio measurements and four-wire resistance and temperature measurements. The measurement limit is 200Vpk for all of the terminal pairings: LO sense to LO input, HI sense to LO input, and HI sense to LO sense.

NOTE

*The 200Vpk limit on the sense terminals is the measurement limit. Operational voltages in resistance measurements are much lower – up to ± 12 V in normal operation.*

## IEC Measurement Category II

The instrument is in accordance with measurement category CAT II 300V. When measuring AC mains, the HI and LO input terminals may be connected to AC mains power up to 300 VAC under Measurement Category II conditions as follows.

*Measurement CAT II is for measurement on the circuits directly connected to the main (e.g.* most small appliances, test equipment, etc.). The instrument may be used to make measurements with the HI and LO inputs connected to AC mains power in such devices, or to the branch outlet itself (up to 300 VAC). However, the instrument may not be used with its HI and LO inputs connected to AC mains power in permanently installed electrical devices such as the main circuit-breaker panel, sub-panel disconnect boxes or permanently wired motors. Such devices and circuits are subject to overvoltages that may exceed the instrument's protection capabilities.

NOTE

*Voltages above 300 VAC may be measured only in circuits that are isolated from AC mains power. However, transient overvoltages are also present on circuits that are isolated from AC mains power. The instrument is designed to safely withstand occasional transient overvoltages up to 1500 Vpk when measuring voltages greater than 300 VAC. Do not use this equipment to measure circuits where transient overvoltages could exceed this level.*

## Maintenance and Cleaning

**WARNING**

**Live components may be exposed if the covers are opened or parts removed . Prior to cleaning or repairing the instrument, all lines must be detached and the instrument must be turned off.**

- Do not use scouring, chemical or aggressive cleaning agents such as benzene, alcohol or such like.
- For cleaning the instrument or the display and the measuring cables, use a clean, slightly damp, fuzz-free, anti-static cloth.

## Disposal



**This product complies with the WEEE Directive (2002/96/EC) marking equipment.**

Electronic equipment is recyclable material and do not belong in the household waste.

Dispose of an unserviceable product in accordance with the relevant statutory regulations.

Please contact your local service partner to dispose of the product.

# Chapter 2 Quick Start

Basic procedures to help you get started quickly with the instrument.

✧ General Inspection
✧ Brief Introduction
✧ Front Panel Review
✧ Rear Panel Review
✧ Setup the Multimeter
✧ Setting the AC Mains Line Voltage Selector
✧ Fuse Installation
✧ Connect Power
✧ Using Built-in Help System
✧ Firmware Update

# General Inspection

Please check the instrument as following steps after receiving an oscilloscope.

**Check the shipping container for damage**
Keep the damaged shipping container or cushioning material until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically.

**Check the accessories**
Accessories supplied with the instrument are listed in "Accessories" in this manual. If the contents are incomplete or damaged, please notify the franchiser.

- 1 x USB cable
- 1 x Multimeter probe (black and red)
- 1 x Power cord
- 1 x Software and user manual on CD

**Check the instrument**
In case there is any mechanical damage or defect, or the instrument does not operate properly or fails performance tests, please notify the franchiser.

# Brief Introduction

### Features

- Up to 10,000 memory points. Fast reading speeds up to 50,000 readings per second.
- 7½ digits digital DMM with 1nV resolution. With 16 ppm basic DCV accuracy.
- 4.3-inch LCD color display. True RMS AC (voltage & current) measurement.
- Measure DC current down to 1μA range and 0.1pA resolution.
- Graphical display with built-in bar, trend charts, histogram, and statistics.
- Front and rear input terminals provide ideal connection space for bench and system test.
- Dual display allows clear and quick view of voltage and frequency measurements at the same time.
- Various measurements: ACV, DCV, ACI, DCI, 2-wire and 4-wire resistance, capacitance, frequency, period, diode, continuity, temperature.
- Multiple connectivity options - USB 2.0, serial interface RS-232/485, and LAN.
- SCPI commands standard.

### Model

| Model | KM 3700 |
|---|---|
| Digits of Resolution | 7½ |
| Basic DCV Accuracy | 16 ppm |
| Max Reading Rate | 50, 000 rdgs/s |
| Memory | 10, 000 rdgs |
| DCV | 100 mV to 1, 000V |
| ACV (RMS) | 100 mV to 750 V |
| DCI | 1 μA to 10 A |
| ACI | 10 μA to 10 A |
| 2-wire and 4-wire Resistance | 100 Ω to 100 MΩ |
| Continuity, Diode | 1 kΩ, 5V |
| Frequency, Period | 3 Hz to 300 kHz/33ms-333μs |
| Temperature | RTD, Thermistor |
| Capacitance | 1.0000 nF - 100.0 μF |
| Dual Line Display | Yes |
| Display | 4.3-inch LCD color display |
| Statistical Graphics | Histogram, bar chart, trend graph |
| Front Input Terminals | Available |
| Rear Input Terminals | Available |
| USB | Available |
| RS232/485 | Available |
| LAN | Available |
| GPIB | N/A |

# Front Panel Review




| Item | Description |
|---|---|
| 1 | Preset/Default Key |
| 2 | Help Key |
| 3 | USB Port |
| 4 | On/Standby Switch |
| 5 | Softkeys |
| 6 | Cursor Navigation Keypad |
| 7 | Range Selecting Keys |
| 8 | Front/Rear Switch |
| 9 | AC/DC Current Input Terminals |
| 10 | HI and LO Input Terminals |
| 11 | HI and LO Sense Terminals |
| 12 | Measurement Configuration and DMM Operation Keys |
| 13 | Display |

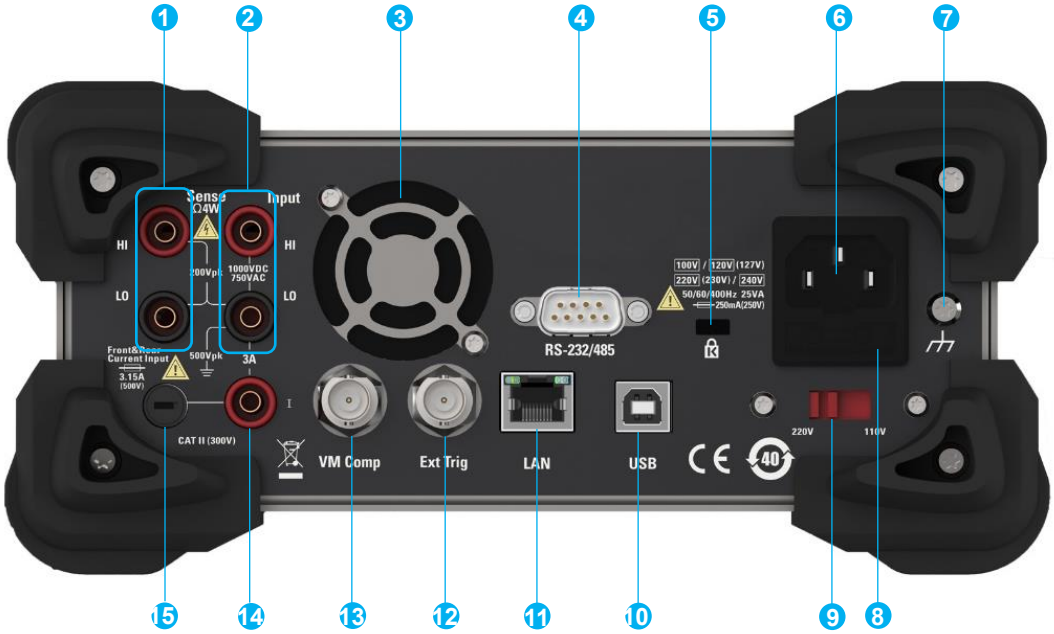
## Front Panel Keys

NOTE

*Some of the front panel keys have text above them. This indicates that the key has a function that you can access by pressing and releasing **[Shift]** before pressing the key. For example, if you press and release **[Shift]** before pressing **[Display]**, you will access the **[Utility]** function:*



# Rear Panel Review




| Item | Description |
|---|---|
| 1 | HI and LO Sense Terminals |
| 2 | HI and LO Input Terminals |
| 3 | Fan Vents |
| 4 | RS232/485 Connector |
| 5 | Instrument Cable Lock |
| 6 | AC Mains Input |
| 7 | Chassis Ground Screw |
| 8 | Fuse Access |
| 9 | AC Mains Line Voltage Selector |
| 10 | USB Interface Connector |
| 11 | Local Area Network (LAN) Connector |
| 12 | External Trigger Input |
| 13 | Voltmeter Measurement Complete Output |
| 14 | 3 A Current Terminal |
| 15 | 3 A Current Terminal Fuse |

# Setup the Multimeter

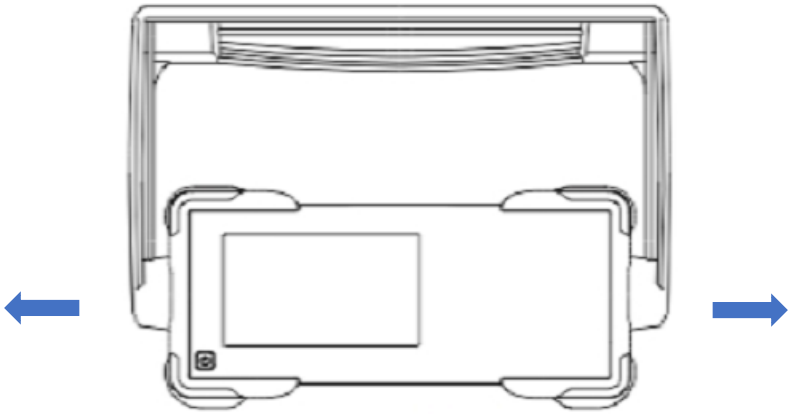
The purpose of this section is to prepare you to use the multimeter.

## Adjust the handle

You may adjust the carrying handle to suit your needs.

## Adjust the handle position

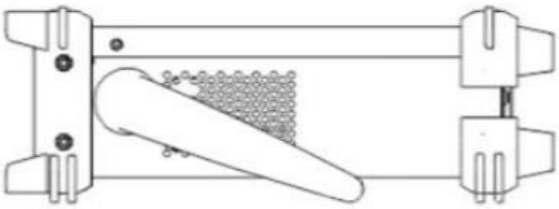
Pull slightly outward on both sides of the handle and slowly rotate it up as shown as follows.



You can adjust DMM's handle to suit your needs.

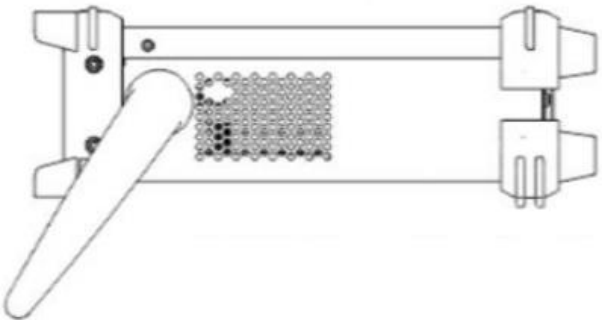
**Position 1 Default**

The default position is used for packing the DMM.



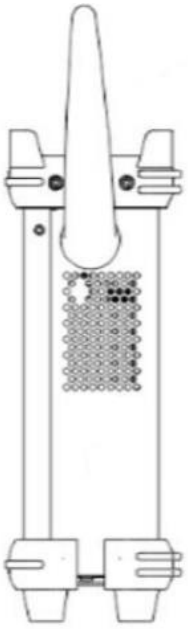
**Position 2 Operating**

The adjusted handle position shown below is for DMM operation.



**Position 3 Carrying**

The carrying position is as follows.



# Setting the AC Mains Line Voltage Selector

**WARNING**

Before plugging the instrument into AC mains power, verify that the line voltage setting visible on the back of the AC mains input module is correct for the AC mains power source being connected. The line voltage selections are shown on the rear anel beneath of the AC mains input module.

| AC mains nominal line voltage range | AC mains line voltage selector |
|---|---|
| 110V - 115V | 110V |
| 120V - 127V | |
| 202V - 230V | 220V |
| 240V | |



# Fuse Installation

**WARNING**

Before replacing the power-line fuse, verify that the DMM is disconnected from AC power. You must be qualified personnel to perform this action.

**CAUTION**

For continued protection against fire or instrument damage, only replace the fuse with the same type and rating. If the instrument repeatedly blows fuses, have the unit serviced at an authorized repair facility.

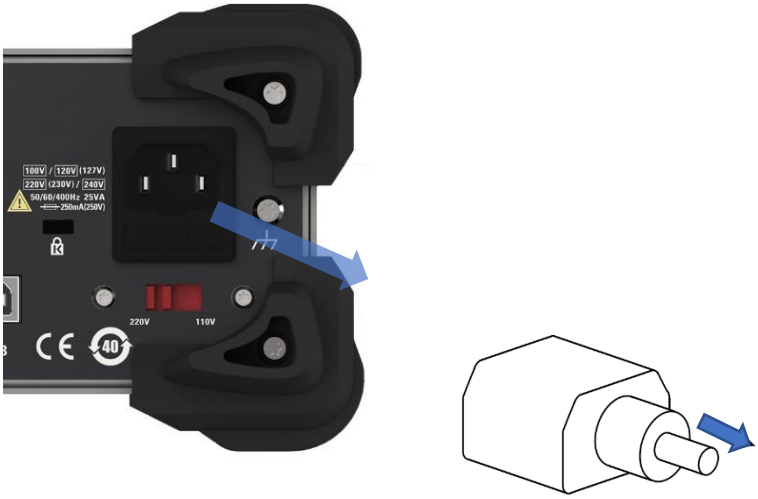
## Power line fuse

A power-line fuse located next to the AC receptacle protects the power line input of the instrument. Verify that the power-line fuse is good and replace it with a new one if it is damaged. The DMM is shipped from the factory with a 3.15A/500V, 5×20mm slow-blow glass fuse installed. This is the correct fuse type for all line voltage settings; use only this type of replacement fuse.

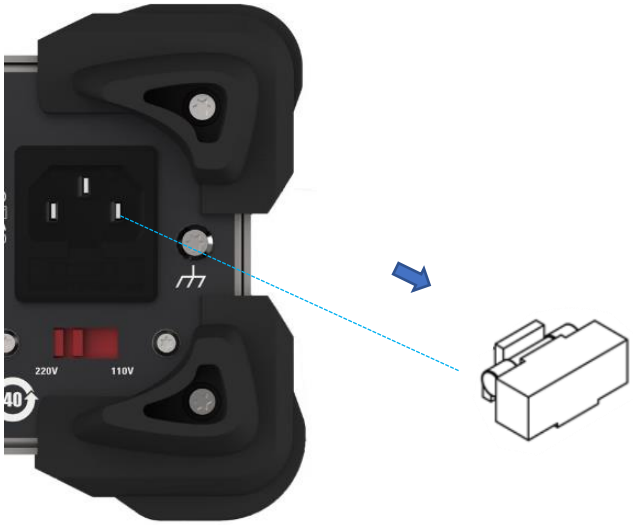


## To change the power line fuse

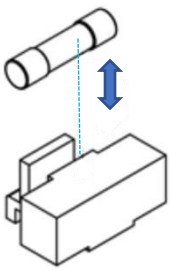
**Step 1** Verify that the DMM is disconnected from AC power.



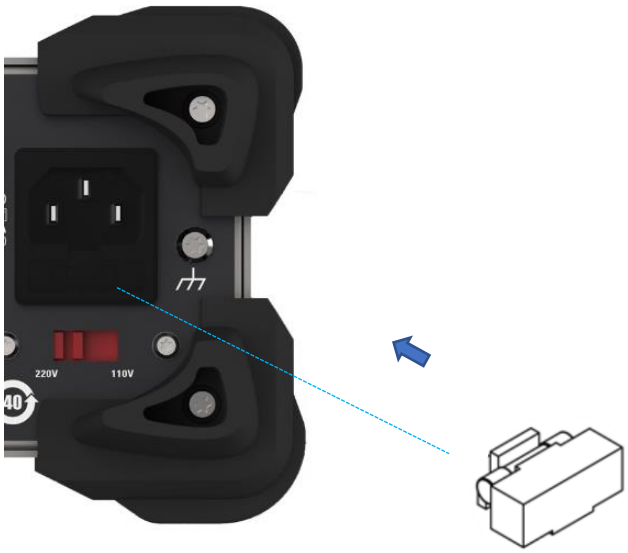

**Step 2** Pull the fuse holder out of the power supply.




**Step 3** Remove and insert the proper fuse into the fuse holder.



**Step 4** Re-insert the fuse holder into the power supply.




## WARNING Product Grounding

The instrument is a Class 1 product and is provided with a grounding-type power cord set. The instrument chassis and cover are connected to the instrument's electrical ground to minimize shock hazards.

The ground pin of the cord set plug must be firmly connected to the electrical ground (safety ground) of the terminal at the power outlet. Any interruption of the protective earth (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury or death.

# Connect Power

This DMM can accept the power supply of 100-120VAC (±10%), 40-400 Hz or 120-240VAC (±10%), 40-60Hz. Please use the power cord supplied with the accessories to connect the instrument to the power supply.

### Power Switch

Press the power switch in the lower left corner of the front panel.



If the DMM does not turn on, verify that the power cord is firmly connected, that the fuse is good, and that the line voltage selector is set correctly, as described above. Also, make sure that the DMM is connected to an energized power source.

To turn off the DMM, press and hold the power switch for about 500 ms. This prevents you from accidentally turning off the DMM by brushing against the power switch.

NOTE

*If you turn off the DMM by disconnecting power (this is not recommended), the DMM turns on as soon as you re-apply power. You will not need to press the power switch.*

# Using Built-in Help System

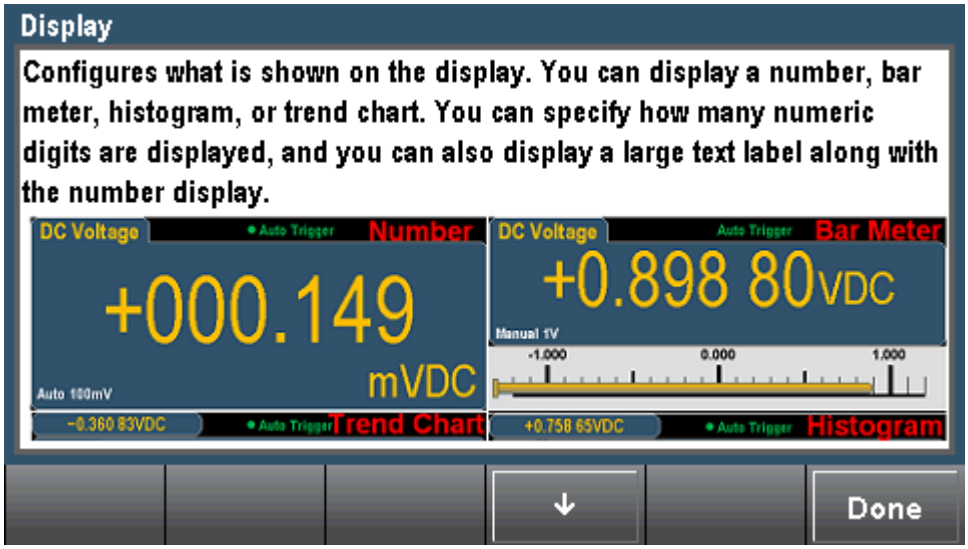
The built-in help system provides context-sensitive help on any front panel key or menu softkey.

A list of help topics is also available to help you learn about the instrument.

## View the help information for a front panel key

Press and hold any softkey or button, such as **[Display]**.

If the message contains more information than fits on the display, press the down arrow softkey to scroll down.

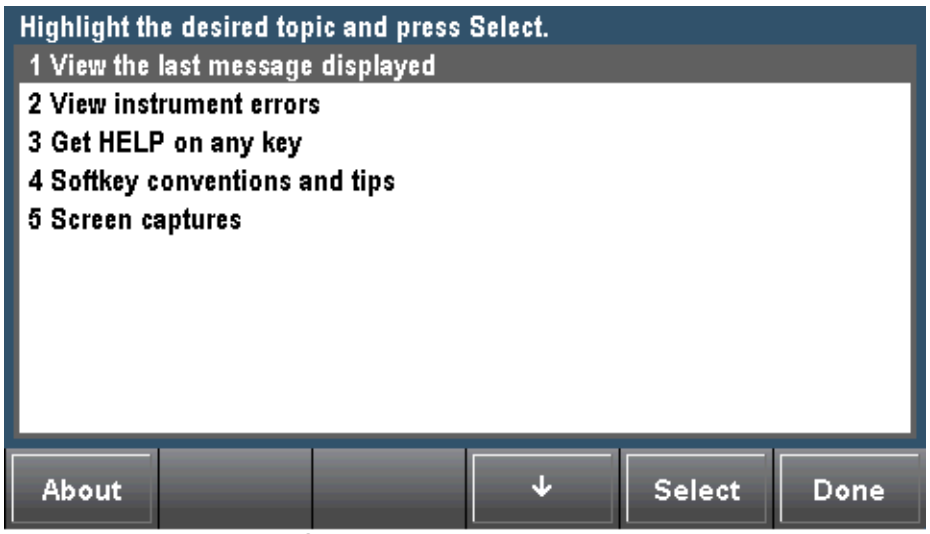


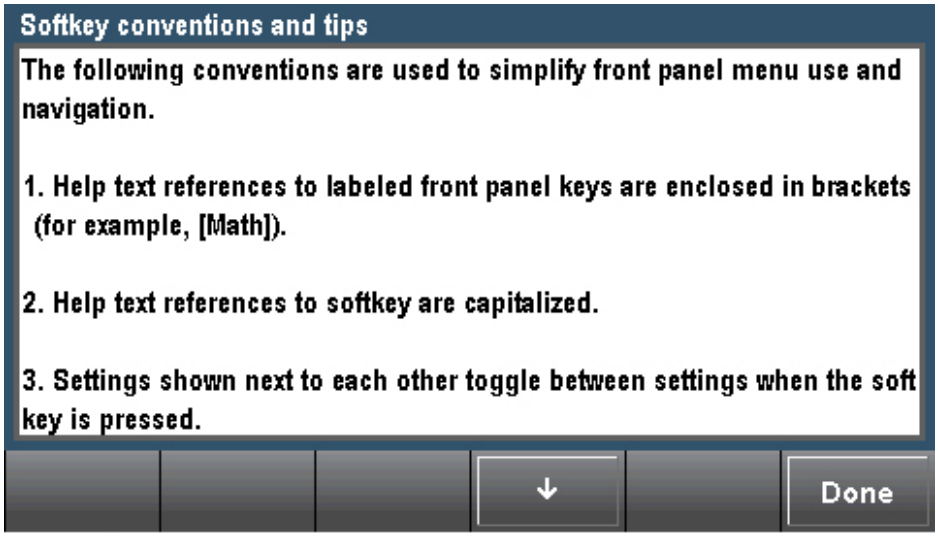

Press **Done** to exit Help.

## View the list of help topics

Press 

to view the list of help topics. Press the arrow softkeys or use the front panel arrow keys to highlight the desired topic. Then press **Select**.






## View the list of recent instrument errors.

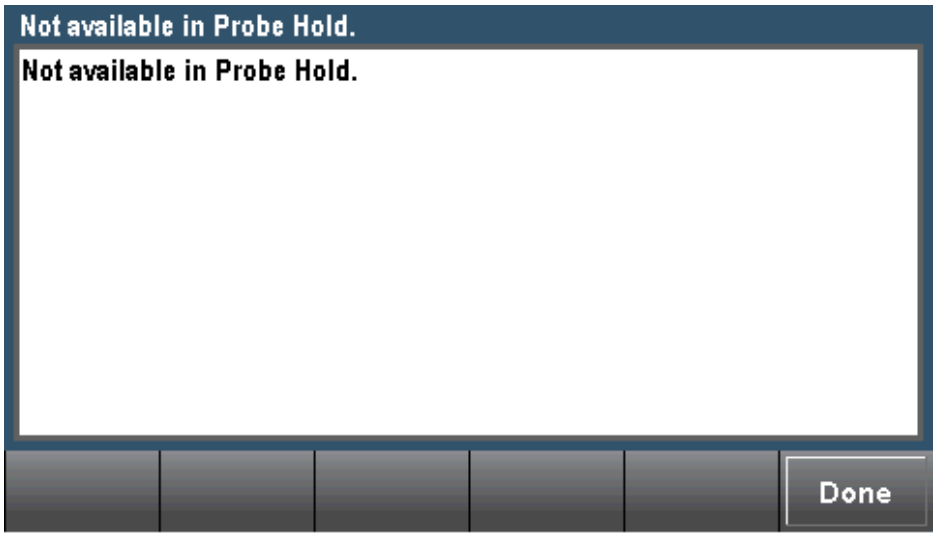
Press ? and choose **View instrument errors** from the list of help topics.

This displays the instrument's error queue, which includes up to 20 errors.

**View the help information for displayed messages.**

Whenever a limit is exceeded or any other invalid configuration is found, the DMM displays a message. And the built-in help system provided the message information review.

Press ? and choose **View the last message displayed** from the list of help topics.




Press **Done** to exit Help.

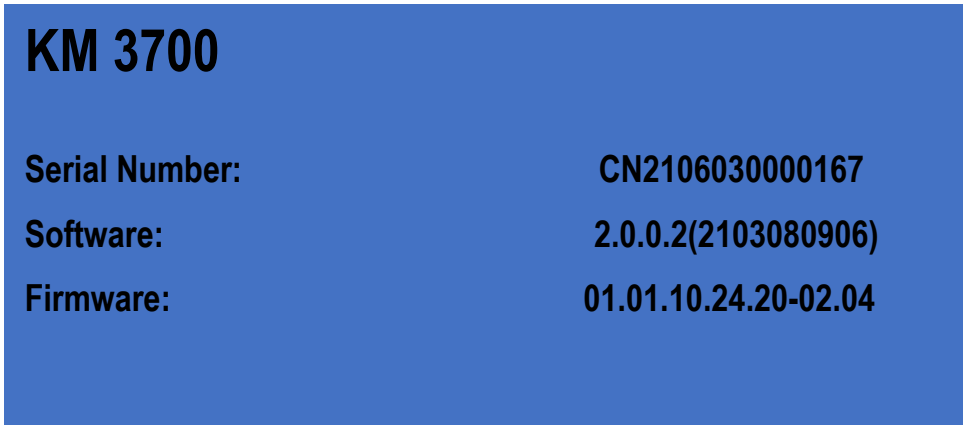
# Firmware Update

Use the following procedure to update DMM firmware:

**CAUTION**

Do not turn off the DMM during the update.

1 Press **[Help] > About** determining what instrument firmware version is currently installed.



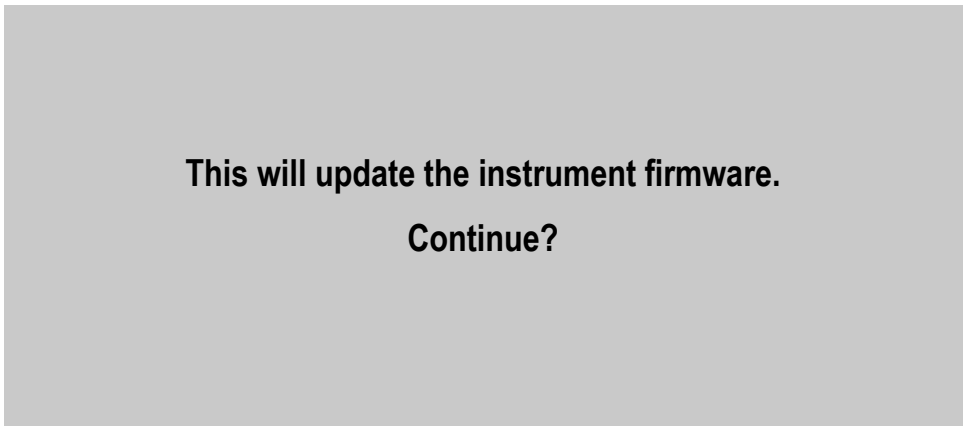

2 Go to the seller to find the latest firmware version. If this matches the version installed on your instrument, there is no need to continue with this procedure. Otherwise, download the firmware update utility and a ZIP file of the firmware.

3 Unzip the ZIP file and use the firmware update utility to prepare a USB drive with the updated firmware.

4 Attach the USB drive to the instrument front panel.



5 And press **[Utility] > Test / Admin > Firmware Update** to update the firmware.






# Chapter 3 Features and Functions

This section contains details on DMM features.

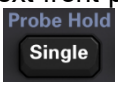
✧ Front Panel Menu Reference
✧ Measurements
✧ Triggering and Readings
✧ Probe Hold
✧ Math Introduction
✧ Display Introduction
✧ Utility Menu Introduction

# Front Panel Menu Reference

The following table summarizes the front panel keys and the menu structure.

| Key | Purpose |
|---|---|
|  | Configure DC voltage measurements, including DCV ratio measurements:<br>**Range:** Auto-range (default), 100 mV, 1 V, 10 V, 100 V, or 1000 V<br>**Aperture PLC:** 0.001, 0.02, 0.2, 1, 10, 100. Default: 10<br>**Auto Zero:** Off or On (default)<br>**Input Z:** 10 MΩ (default) or Auto Ω (> 1 GΩ)<br>**DCV Ratio:** Off (default) or On |
|  | Configure DC current measurements:<br>**Terminals:** 3 A or 10 A<br>**Range:** Auto, 1 µA,10 µA,100 µA, 1 mA, 10 mA, 100 mA, 1 A, 3 A or 10 A (when terminals set to 10 A).<br>**Aperture PLC:** 0.02, 0.2, 1, 10, 100. Default: 10<br>**Auto Zero:** Off or On (default) |
|  | Configure AC voltage measurements:<br>**Range:** Auto-range (default), 100 mV, 1 V, 10 V, 100 V or 750 V<br>**AC Filter:** >3 Hz, >20 Hz, >200 Hz |
|  | Configure AC current measurements:<br>**Terminals:** 3 A or 10 A<br>**Range:** Auto, 10 µA,100 µA, 1 mA, 10 mA, 100 mA, 1 A, 3 A or 10 A (when terminals set to 10 A)<br>**AC Filter:** >3 Hz, >20 Hz, >200 Hz |
|  | Configure 2-wire resistance measurements:<br>**Range:** 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ or 100 MΩ or Auto (default).<br>NOTE *The approximate current sourced for each range (for example, ~1mA) is shown on each range softkey.*<br>**Aperture PLC:** 0.02, 0.2, 1, 10, 100. Default: 10<br>**Auto Zero:** Off or On (default) |
|  | Configure 4 wire resistance measurements.<br>**Range:** 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ or 100 MΩor Auto (default).<br>NOTE *The approximate current sourced for each range (for example, ~1mA) is shown on each range softkey.*<br>**Aperture PLC:** 0.02, 0.2, 1, 10, 100. Default: 10 |
|  | Configure frequency and period measurements. Parameters include range, AC filter, and gate time.<br>**Range:** 100 mV, 1 V, 10 V, 100 V, 750 V, Auto (default)<br>**AC Filter:** >3 Hz, >20 Hz, >200 Hz<br>**Gating Time:** 10 ms, 100 ms (default), or 1 s<br>**Timeout:** 1 s (default) or Auto |
|  | Configure capacitance measurements:<br>**Range:** 1 nF, 10 nF, 100 nF, 1µF, 10µF, 100µF, or Auto (default) |

| Key | Purpose |
|---|---|
|  | Configure continuity measurements:<br>**Beeper:** Off or On (default) |
|  | Configure diode measurements:<br>**Beeper:** Off or On (default) |
|  | Configure 2-wire and 4-wire temperature measurements.<br>**Probe Settings:** RTD 2W, RTD 4W (default), Thermis2W, Thermis4W<br>**Additional settings for probe type RTD 2W or RTD 4W:**<br>**R0:** R0 is the nominal resistance of an RTD at 0 °C. Default 100 Ω<br>**Aperture PLC:** 0.02, 0.2, 1, 10, 100. Default: 10<br>**Auto Zero:** Off or On (default) (2-wire measurements only; not available for 4-wire measurements)<br>**Units:** °C, °F, or K |
|  | Start and stop measurements. |
|  | Store and recall instrument states and preferences. |
|  | Take a single measure. |
|  | Take one or more hand-free measurements. |
|  | Take a null measurement. |
|  | Configure the null function, scaling, statistics, and limits. |
|  | Configure the text and graphics that appear on the display and secondary measurements. |
|  | Store and recall instrument states and preferences.<br>Configure I/O interfaces: LAN, USB<br>Perform system administration tasks, including calibration.<br>Configure user preferences.<br>Perform file management activities, including the creation of “screen shot” files (display images). |
|  | Configure triggering.<br>Set the slope of VM Comp output.<br>Save readings |

| Key | Purpose |
|---|---|
|   | Learn about the instrument, view the last error message, or clear error messages. |
|   | Select manual or auto range. Press + to manually uprange, press − to manually downrange. |
|   | Return to local control of the instrument (when in Remote mode) or indicate that the next front panel key will be "shifted", for example **[Probe Hold]**   instead of **[Single]**. |

The keys that access a wide range of functions are listed below.

**[Acquire] Key**




| Softkey | Description |
|---|---|
| **Trg Src** | Select trigger source. |
| **Delay** | Auto or manual. |
| **Sample/Trigger** | Setup the samples per trigger. |
| **VMC Out** | Set slope of VM Comp output. |
| **Save Readings** | Save readings to a file. |

**[Math] Key**




The availability of Math softkeys varies by measurement function.

| Softkey | Description |
|---|---|
| **DCV Null** | Enable/disable use of null values and specify null value to use. |
| **dB / dBm** | Configure dB, dBm. |
| **Statistics** | Enable, disable, and clear statistics. |
| **Limits** | Enable or disable high and low limits. |

### [Display] Key




| Softkey | Description |
|---|---|
| **Display** | Choose what to display: number, bar meter, histogram, or trend chart. |
| **Label** | Enable or disable the display of a message. |
| **Label Text** | Edit the text displayed when the Label softkey is on. |
| **2nd Meas** | Select a secondary measurement. |
| **Digit Mask** | Set the number of digits displayed in the measurements. |

### [Utility] Key




| Softkey | Description |
|---|---|
| **Store/Recall** | Store and recall state and preference files and set power-on defaults, set to defaults interface. |
| **Manage Files** | Perform basic file management tasks and screen captures. |
| **I/O Config** | Configure LAN, USB<br>Select SCPI mode. |
| **Test/Admin** | Perform self-test, calibration, and firmware update tasks. |
| **System Setup** | Set user preferences, date, and time. |

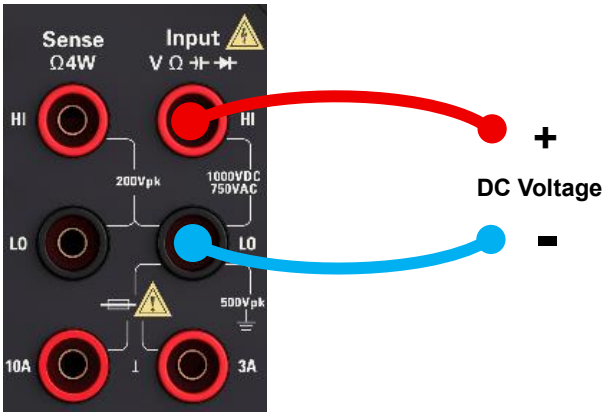
# Measurements

KM 3700 DMM supports many common measurements:

## DC Voltage

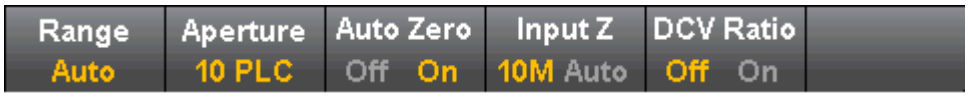
This section describes how to configure DC voltage measurements from the front panel, including DCV ratio measurements.

**Step 1:** Configure the test leads as shown.




**Step 2:** Press **[DCV]** on the front panel.

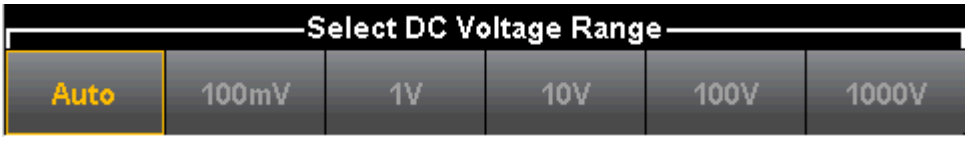
**Step 3:** Press **Aperture** and choose the number of power-line cycles (PLCs) to use for the measurement.
1, 10, and 100 PLC provide normal mode (line frequency noise) rejection. Selecting 100 PLC provides the best noise rejection and resolution, but the slowest measurements:







**Step 4:** Press **Range** to select a range for the measurement. You can also use **[+]**, **[-]**, and **[Range]** keys on the front panel to select the range. **Auto** (auto range) automatically selects the range for the measurement based on the input. Auto ranging is convenient, but it results in slower measurements than using a manual range. Auto ranging goes up a range at 120% of the present range, and down a range below 10% of the present range.



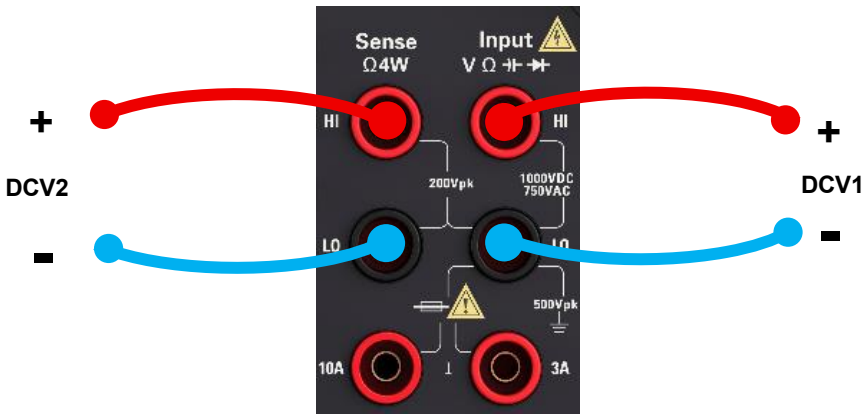
**Step 5: Auto Zero**: Autozero provides the most accurate measurements but requires additional time to perform the zero measurement. With autozero enabled (On), the DMM internally measures the offset following each measurement. It then subtracts that measurement from the preceding reading. This prevents offset voltages present on the DMM's input circuitry from affecting measurement accuracy. With autozero disabled (Off), the DMM measures the offset once and subtracts the offset from all subsequent measurements. The DMM takes a new offset measurement each time you change the function, range, or integration time. (There is no autozero setting for 4-wire measurements.)

**Step 6:** Specify the input impedance to the test leads (**Input Z**). This specifies the measurement terminal input impedance, which is either Auto or 10 MΩ. The Auto mode selects high impedance (High Z) for the 100 mV, 1 V, and 10 V ranges, and 10 MΩ for the 100 V and 1000 V ranges. In most situations, 10 MΩ is high enough to not load most circuits, but low enough to make readings stable for high-impedance circuits. It also leads to readings with less noise than the **High Z** option, which is included for situations where the 10 MΩ load is significant.

## DCV Ratio

The **DCV Ratio** key enables or disables DCV Ratio measurement. Note that the **Auto Zero** softkey disappears when you enable DCV Ratio measurements. This is because autozero cannot be disabled during DCV Ratio.
The ratio is the voltage on the Input terminals divided by the reference voltage. The reference voltage is the difference between two separate measurements. These measurements are the DC voltages from the HI Sense terminal to the LO Input terminal and from the LO Sense terminal to the LO Input terminal. These two measurements must be within the range of ±12 VDC. The reference voltage is always auto ranged, and the range used for both will be based on the larger result of these two measurements.

Configure DCV Ratio measurements as shown:



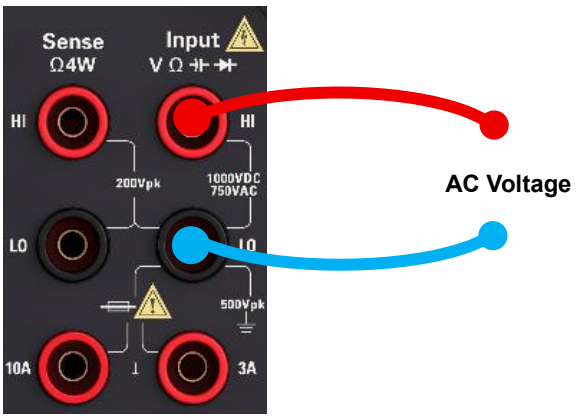
## AC Voltage

This section describes how to configure AC voltage measurements from the front panel.

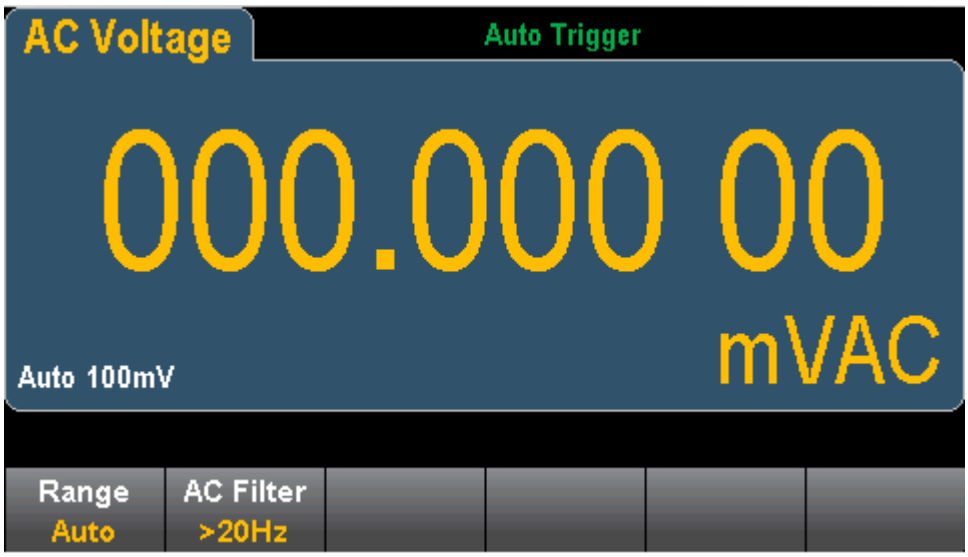
NOTE

*Default delays are selected to give correct first readings for most measurements. For the most accurate measurements, the input blocking RC time constant must settle to 1/50 of the AC signal level. Signals greater than 300 V (rms) or 1 A (rms) will cause self-heating in signal-conditioning components. These errors are included in the instrument specifications. Internal temperature changes due to self-heating may cause additional errors on other functions or ranges. The additional error will generally dissipate within a few minutes.*

**Step 1:** Configure the test leads as shown.



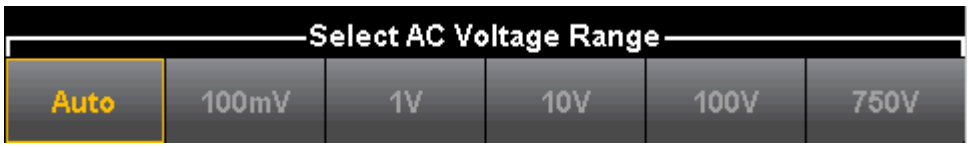

**Step 2:** Press [ACV] on the front panel.




**Step 3:** Press **Range** to select a range for the measurement.

**Auto** (auto-range) automatically selects the range for the measurement based on the input. Auto ranging is convenient, but it results in slower measurements than using a manual

range. Auto ranging goes up a range at 120% of the present range and down a range below 10% of the present range.




**Step 4:** Press **AC Filter** and choose the filter for the measurement. The instrument uses three different AC filters that enable you either to optimize low-frequency accuracy or to achieve faster AC settling times following a change in input signal amplitude.
The three filters are 3 Hz, 20 Hz, and 200 Hz. You should generally select the highest frequency filter whose frequency is less than that of the signal you measure because higher frequency filters result in faster measurements. For example, when measuring a signal between 20 and 200 Hz, use the 20 Hz filter.
If measurement speed is not an issue, choosing a lower frequency filter may result in quieter measurements, depending on the signal that you are measuring.



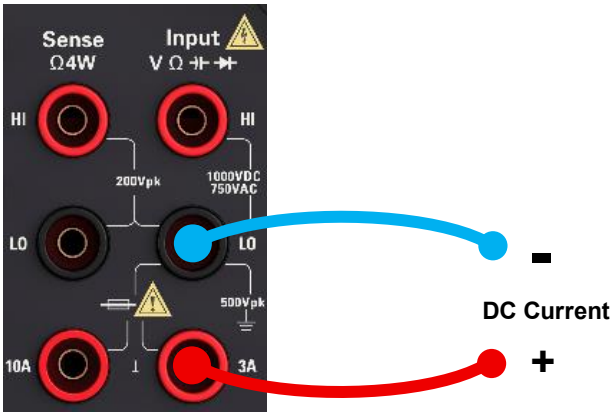

NOTE

*For accurately displayed statistics of AC measurements in front panel mode, the default manual trigger delay (**[Acquire] >Delay Man**) must be used.*

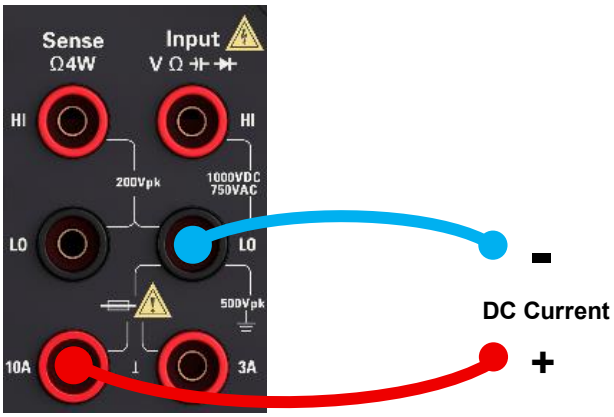
## DC Current

This section describes how to configure DC current measurements from the front panel.

**Step 1:** Configure the test leads as shown.




You can also configure the measurement using the 10 A terminal, which is recommended when measuring current above 3 A:



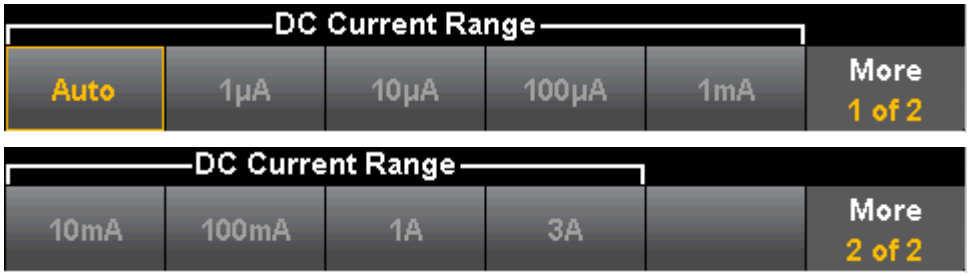

**Step 2:** Press **[DCI]** on the front panel.




**Step 3:** Press the **Aperture** softkey and use the up/down arrow keys to specify integration time in power-line cycles (PLCs) to use for the measurement. 1, 10, and 100 PLC provide normal mode (line frequency noise) rejection. Selecting 100 PLC provides the best noise rejection and resolution, but the slowest measurements.

**Step 4**: The 3A terminals are selected by default. The **Terminals** softkey toggles between the 3 A terminals and the 10 A input terminals. When you change this to 10 A, the measurement range automatically becomes 10 A.

**Step 5:** Press **Range** to select a range for the measurement. You can also use **[+]**, **[-]**, and **[Range]** keys on the front panel to select the range. **Auto** (auto range) automatically selects the range for the measurement based on the input. Auto ranging is convenient, but it results in slower measurements than using a manual range. Auto ranging goes up a range at 120% of the present range and down a range below 10% of the current range. Press **More** to switch between the two pages of settings.

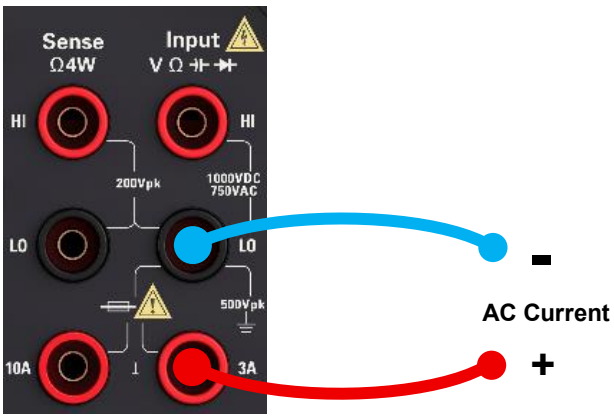



**Step 6: Auto Zero**: Autozero provides the most accurate measurements but requires additional time to perform the zero measurement. With autozero enabled (On), the DMM internally measures the offset following each measurement. It then subtracts that measurement from the preceding reading. This prevents offset voltages present on the DMM's input circuitry from affecting measurement accuracy. With autozero disabled (Off), the DMM measures the offset once and subtracts the offset from all subsequent measurements. The DMM takes a new offset measurement each time you change the function, range, or integration time. (There is no autozero setting for 4-wire measurements.)

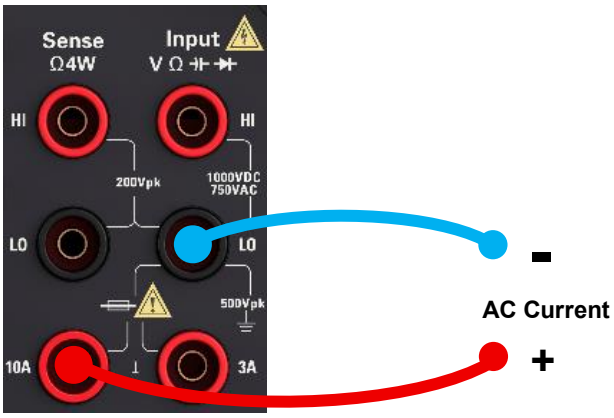
## AC Current

This section describes how to configure AC current measurements from the front panel.

**Step 1:** Configure the test leads as shown.




You can also configure the measurement using the 10 A terminal, which is recommended when measuring current above 3 A:



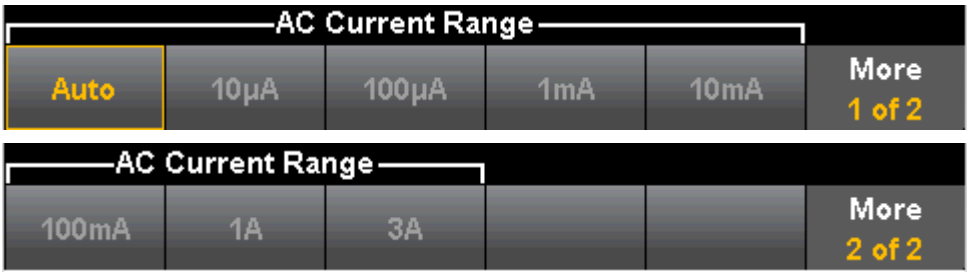

**Step 2:** Press **[ACI]** on the front panel.




**Step 3:** The 3A terminals are selected by default. The **Terminals** softkey toggles between the 3 A terminals and the 10 A input terminals. When you change this to 10 A, the measurement range automatically becomes 10 A.

**CAUTION** When making measurements using the 10A terminals, the presence of a signal on the 3A terminals can cause significant errors.

**Step 4:** Press **Range** to select a range for the measurement. You can also use **[+]**, **[-]**, and **[Range]** keys on the front panel to select the range. **Auto** (autorange) automatically selects the range for the measurement based on the input. Autoranging is convenient, but it results in slower measurements than using a manual range. Autoranging goes up a range at 120% of the present range, and down a range below 10% of the present range. Press **More** to switch between the two pages of settings.




**Step 5:** Press **AC Filter** and choose the filter for the measurement. The instrument uses three different AC filters that enable you either to optimize low frequency accuracy or to achieve faster AC settling times following a change in input signal amplitude. The three filters are 3 Hz, 20 Hz, and 200 Hz, and you should generally select the highest frequency filter whose frequency is less than that of the signal you are measuring, because higher frequency filters result in faster measurements. For example, when measuring a signal between 20 and 200 Hz, use the 20 Hz filter.

If measurement speed is not an issue, choosing a lower frequency filter may result in quieter measurements, depending on the signal that you are measuring.




**NOTE**

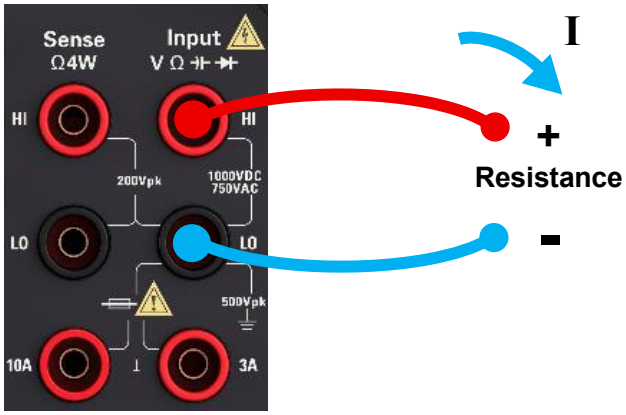
*For accurate displayed statistics of AC measurements in Front Panel mode, the default manual trigger delay (**[Acquire] > Delay Man**) must be used.*

## Resistance

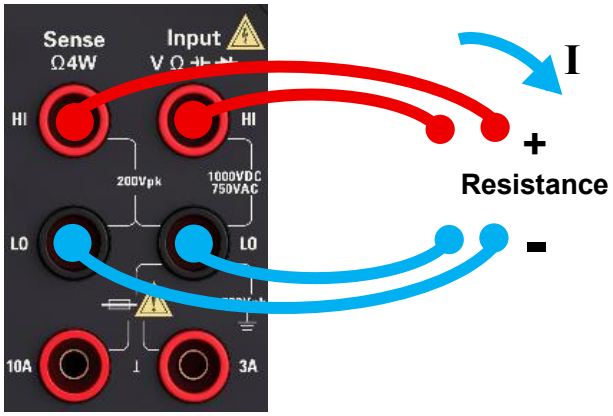
This section describes how to configure 2-wire and 4-wire resistance measurements from the front panel.

**Step 1:** Configure the test leads as shown.

**2-wire Resistance:**




**4-wire Resistance:**




**Step 2:** Press **[Ω2W]** or **[Ω4W]** on the front panel. The following menu appears. (The Ω4W menu does not include **Auto Zero**.)

| Range | Aperture | Auto Zero | | | |
|---|---|---|---|---|---|
| Auto | 10 PLC | Off On | | | |

**Step 3:** The **Aperture** softkey is selected by default. Use the up/down arrow keys to specify integration time in power-line cycles (PLCs) to use for the measurement. 1, 10, and

100 PLC provide normal mode (line frequency noise) rejection. Selecting 100 PLC provides the best noise rejection and resolution, but the slowest measurements.

**Step 4:** Press **Range** to select a range for the measurement. **Auto** (autorange) automatically selects the range for the measurement based on the input. Autoranging is convenient, but it results in slower measurements than using a manual range. Autoranging goes up a range at 120% of the present range, and down a range below 10% of the present range.




Press **More** to switch between the two pages of settings.




NOTE

*The amount of test current sourced is shown for each range. After selecting a range, the main resistance menu is displayed.*

**Step 5: Auto Zero**: Autozero provides the most accurate measurements but requires additional time to perform the zero measurement. With autozero enabled (On), the DMM internally measures the offset following each measurement. It then subtracts that measurement from the preceding reading. This prevents offset voltages present on the DMM's input circuitry from affecting measurement accuracy. With autozero disabled (Off), the DMM measures the offset once and subtracts the offset from all subsequent measurements. The DMM takes a new offset measurement each time you change the function, range, or integration time. (There is no autozero setting for 4-wire measurements.)

## Negative Resistance Measurements

Under certain conditions, the instrument may report negative resistance measurements. These may occur in 2-wire and 4-wire resistance measurements or continuity measurements.

Conditions that may cause negative ohms values include:

- Changes in Front/Rear switch contact resistance
- Reversed Sense Hi and Lo leads
- Circuits with external bias or thermal voltages at circuit connections
- Changes in measurement connection after a NULL operation

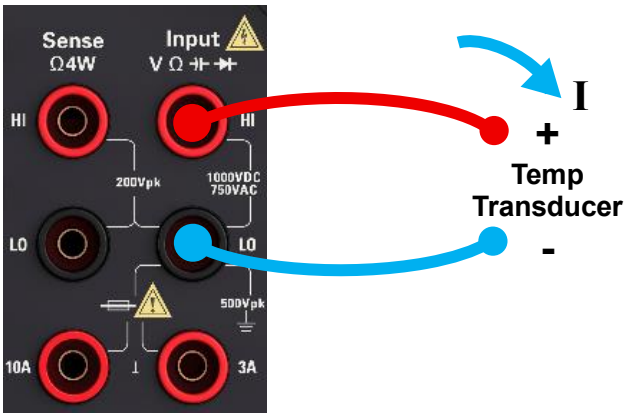
Under the same conditions, the DMM returns the measurement's absolute value so as to prevent confusion associated with negative readings. The KM 3700 DMMs will return negative values. This allows the most accurate results after a NULL operation.

## Temperature

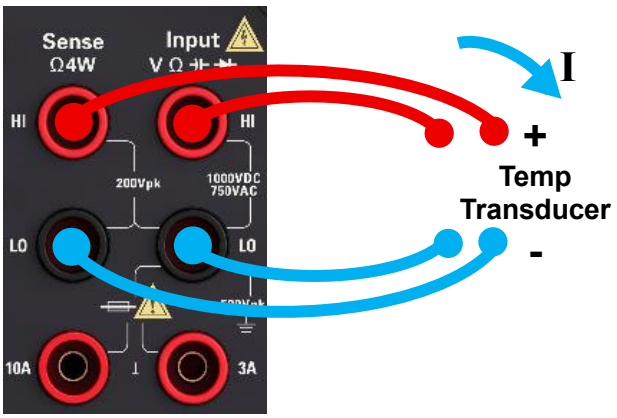
This section describes how to configure 2-wire and 4-wire temperature measurements from the front panel.
Temperature measurements require a temperature transducer probe. The supported probes are 2-wire and 4-wire RTDs, 2-wire and 4-wire thermistors.

**Step 1:** Configure the test leads as shown.

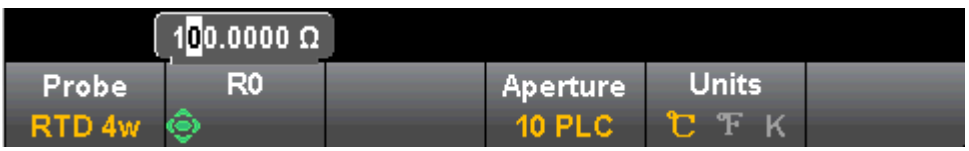
**2-wire Temperature:**




**4-wire Temperature:**




**Step 2:** Press **[Temp]** on the front panel. The following menu appears.




**Step 3:** Press **Probe** and choose the probe type.

Additional settings for each probe type are described in the sections below.

RTDs offer high accuracy and a linear relationship between resistance and temperature over a wide range (approximately -200°C to 500 °C) making conversion straightforward.

Thermistors, being semiconductors, have significantly higher sensitivity but a narrower temperature range (-80°C to 150 °C) and a non-linear resistance-temperature relationship, requiring more complex conversion algorithms.

**Important:** Use only a 5 kΩ 44007 type thermistor. This type of thermistor has constants of A = 1.285e-3, B = 2.362e-4, C = 9.285e-8. Using an incorrect type of thermistor can result in errors greater than 20 °C for a temperature being measured of 100 °C.

If you choose to use an RTD, the menu will have a softkey to specify the RTD's resistance at 0 degrees Celsius ($R_0$).




**Step 4:** For 2-wire measurements, an **Auto Zero** softkey is available.

**Auto Zero**: Autozero provides the most accurate measurements but requires additional time to perform the zero measurement. With autozero enabled (On), the DMM internally measures the offset following each measurement. It then subtracts that measurement from the preceding reading.

This prevents offset voltages present on the DMM's input circuitry from affecting measurement accuracy. With autozero disabled (Off), the DMM measures the offset once and subtracts the offset from all subsequent measurements. The DMM takes a new offset measurement each time you change the function, range, or integration time. (There is no autozero setting for 4-wire measurements.)

**Step 5:** Press **Aperture** and choose the number of power-line cycles (PLCs) to use for the measurement. Only 1, 10, and 100 PLC provide normal mode (line frequency noise) rejection. Selecting 100 PLC provides the best noise rejection and resolution, but the slowest measurements:



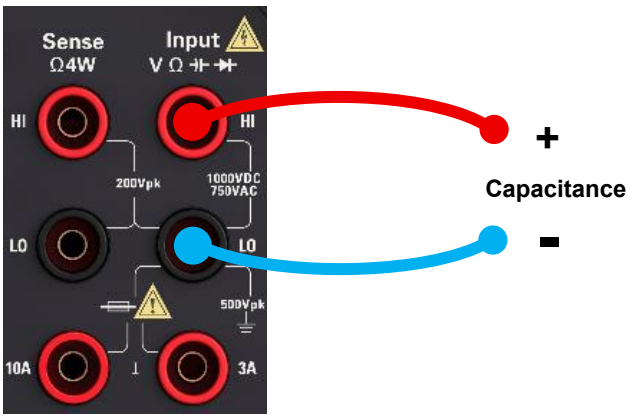

**Step 6:** Use the **Units** softkey to display temperature in degrees Celsius, degrees Fahrenheit, or Kelvin.

Temperature measurements require a temperature transducer probe. The supported probes are 2-wire and 4-wire RTDs, 2-wire and 4-wire thermistors (5k 44007 type).

## Capacitance

This section describes how to configure capacitance measurements from the front panel.

**Step 1:** Configure the test leads as shown.




**Step 2:** Press  on the front panel.


**Step 3:** To null-out the test lead capacitance:

- Disconnecting the + and - test leads probe end from the test circuit and leaves open.
- Press **Null**. The DMM will now subtract this null value from capacitance measurements.

**Step 4:** Press **Range** to select a range for the measurement. You can also use **[+]**, **[-]**, and **[Range]** keys on the front panel to select the range. **Auto** (autorange) automatically selects the range for the measurement based on the input. Autoranging is convenient, but it results in slower measurements than using a manual range. Autoranging goes down a range at less than 10% of range and up a range at greater than 120% of range. For capacitance measurements only, when autorange is off, the instrument does not report an overload for readings greater than 120% of range.

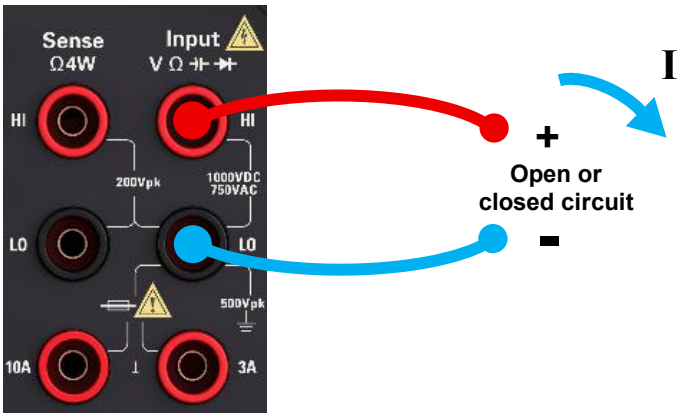
Overload only occurs when the algorithm times out because the applied capacitance is too large for the algorithm to measure. If you apply a DC voltage or a short to the input terminals in capacitance measurement mode, the instrument reports an overload.



## Continuity

This section describes how to configure continuity tests from the front panel.

**Step 1:** Configure the test leads as shown.




**Step 2:** Press **[Cont]** on the front panel to open a menu where you can enable or disable the beeper for all functions that use the beeper (limits, probe hold, diode, continuity, and errors).



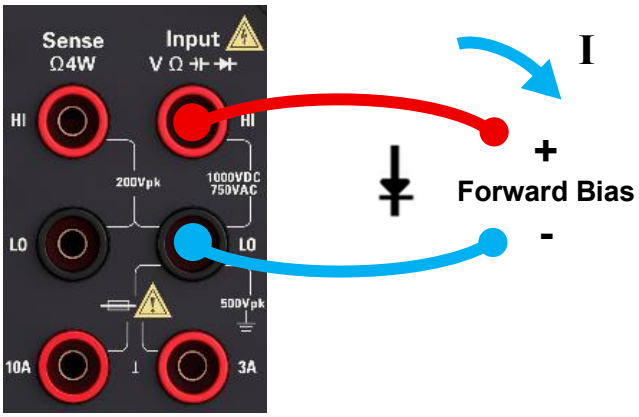

Continuity measurements behave as follows:

| | |
|---|---|
| ≤ 10 Ω | Displays measured resistance and beeps (if beeper enabled) |
| 10 Ω to 1.2 kΩ | Displays measured resistance without beeping |
| > 1.2 k Ω | Displays OPEN with no beep |

## Diode

This section describes how to configure diode tests from the front panel. The range and resolution are fixed; the range is 10 VDC (with a 1 mA current source output).

**Step 1:** Configure the test leads as shown.




**Step 2:** Press on the front panel to open a menu that specifies whether the DMM will beep to indicate a successful diode test.



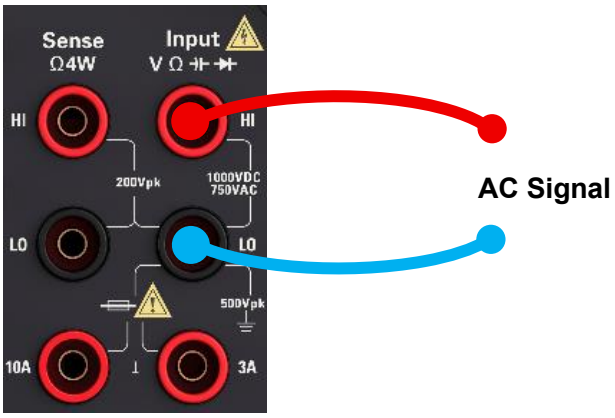

Diode measurements behave as follows:

| | |
|---|---|
| 0 to 4.9 V | Voltage displayed on the front panel and DMM beeps when signal transitions into the 0.3 to 0.8V threshold (if beeping is enabled). |
| > 5 V | The front panel displays OPEN |

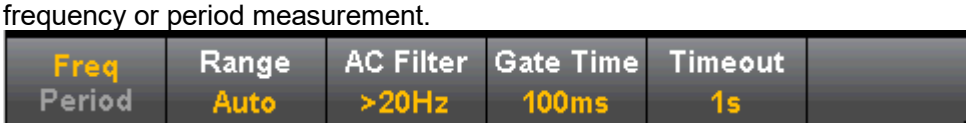
## Frequency and Period

This section describes how to configure frequency and period measurements from the front panel.

**Step 1:** Configure the test leads as shown.




**Step 2:** Press **[Freq]** on the front panel and then use the first softkey to choose either frequency or period measurement.




**Step 3:** Press **Range** to select a range for the measurement. **Auto** (autorange) automatically selects the range for the measurement based on the input. Autoranging is convenient, but it results in slower measurements than using a manual range. Autoranging goes up a range at 120% of the present range, and down a range below 10% of the present range.




**Step 4:** Press **AC Filter** and choose the filter for the measurement. The instrument uses three different AC filters that enable you either to optimize low frequency accuracy or to achieve faster AC settling times following a change in input signal amplitude.

The three filters are 3 Hz, 20 Hz, and 200 Hz, and you should generally select the highest frequency filter whose frequency is less than that of the signal you are measuring, because higher frequency filters result in faster measurements. For example, when measuring a signal between 20 and 200 Hz, use the 20 Hz filter.

If measurement speed is not an issue, choosing a lower frequency filter may result in quieter measurements, depending on the signal that you are measuring.



**Step 5:** Press **Gate Time** and choose the measurement aperture (integration time) of 10 ms,100 ms (default), or 1 s.




**Step 6:** Press **Timeout** to control how long the instrument waits before timing out on a frequency or period measurement when no signal is present. When set to 1s, the instrument waits 1 second before timing out. When set to Auto, the wait time varies with AC filter bandwidth; for the faster bandwidths, the instrument waits a shorter time before timing out and returning 0.0. This is advantageous in manufacturing test systems where a DUT failure may result in no signal; in this case, the failure can be detected sooner, speeding up test throughput.




NOTE

*For accurate displayed statistics of AC measurements in Front Panel mode, the default manual trigger delay (**[Acquire] > Delay Man**) must be used.*

## Secondary Measurement

Most measurement functions allow you to select and display a secondary measurement function. Secondary measurements can be displayed in the Number and Bar Meter displays only. For example, a thermistor temperature measurement (primary) and the resistance measurement made on the thermistor (secondary) are shown below:




To select a secondary measurement from the front panel, first select the primary measurement function and then press **Display**:




Press **2nd Meas** and select the secondary measurement.
The primary measurement functions and their associated secondary measurements for each DMM model are:

| Primary Measurement Function | Secondary Measurement Function |
|---|---|
| **DCV** | ACV |
| **ACV** | Frequency |
| **DCI** | ACI |
| **ACI** | Frequency |
| **Frequency** | Period |
| **Period** | Frequency |
| **Temperature** | Sensor |
| **Ratio** | Input/Ref |

Where:

- Sensor - The raw sensor value; ohms for thermistor/RTD.
- Input/Ref - The DC signal voltage and the DC reference voltage measurements.
- After making one or more primary measurements for approximately 4 seconds, the DMM makes one secondary measurement.

# Triggering and Readings

The trigger model and large reading memory provide versatile capabilities for a wide variety of applications.

### Instrument trigger model

Acquiring measurements on the DMM is done as the result of triggering. This section describes how to configure triggering.

Pressing **[Acquire]** opens the following menu:




The menus above allow you to configure measurement triggering, and you can also use the **VMC Out** softkey to set the edge slope of the **VM Comp** (voltmeter complete) output on the instrument's rear panel. This connector issues a signal whenever the voltmeter finishes taking a measurement to allow you to signal other devices in a measurement system.

NOTE
*For accurate displayed statistics of AC measurements in Front Panel mode, the default manual trigger delay (**[Acquire] > Delay Man**) must be used.*

The **(Trg Src)** menu allows you to select one of these trigger sources:




**Auto -** the instrument continuously takes measurements, automatically issuing a new trigger as soon as a measurement is completed.

**Single -** the instrument issues one trigger each time the front panel **[Single]** key is pressed.

**Ext -** the instrument issues one trigger each time an edge of the appropriate slope arrives at the rear-panel Ext Trig connector. You can specify the slope on the softkey menu that appears when **Trg Src** is set to Ext.

In the Single, and Ext modes, you can specify the number of samples to be taken per trigger by using the **Samples/Trigger** softkey. The Single and Ext modes can both buffer up to one trigger, meaning that if you press **[Single]** or receive an external trigger while a series of measurements is in progress, the instrument will finish that series of measurements and then immediately launch a new series of measurements based on the trigger.

If multiple **[Single]** or external triggers are issued during a series of measurements, all triggers received after the first are discarded.

The **[Acquire]** menu also configures the delay that occurs before each measurement is taken, regardless of the trigger mode (Auto, Single, or Ext). This may be either automatic (the delay is based on the DMM's settling time) or manual (you specify the delay time).

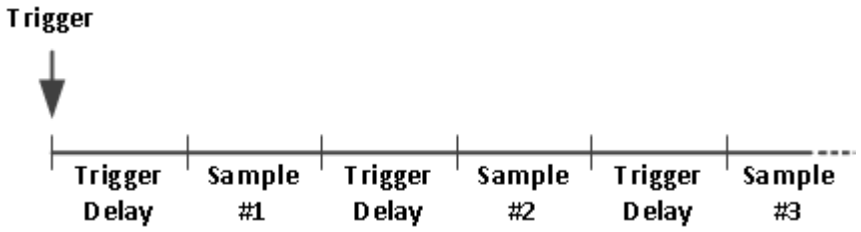
Finally, note the **[Run/Stop]** and **[Single]** keys on the front panel. In Auto trigger mode, pressing **[Run/Stop]** stops and resumes measurements, and pressing **[Single]** switches the instrument to single trigger mode. In the Single and Ext modes, pressing **[Run/Stop]** stops readings if they are in progress, or switches the mode to Auto if readings are stopped.

## Trigger delay and multiple samples

The instrument inserts a trigger delay between the occurrence of a trigger and the first measurement. When **Auto** is used (**Delay Auto** softkey), the instrument automatically determines the delay based on function, range and integration time. However, you may need to manually set a delay (**Delay Man** softkey) longer than the automatic delay to allow the input to settle before pacing a burst of measurements, for measurements with long cables, or for measurements of high capacitance or high impedance signals.

If you have configured the instrument for more than one sample per trigger (**Samples /Trigger** softkey), in all cases, the first sample is taken one trigger delay time after the trigger occurs.

- **Sample Immediate** - After a trigger event, the first sample is taken immediately following a specified delay time. Subsequent samples are taken at regular intervals with the same delay time inserted between them.




In this timed sampling configuration, the “timed” part refers to the deliberate insertion of a fixed delay time after each sample is taken, making it not deterministic. The actual sampling time is influenced by the integration time and range adjustment time.

## Storing and clearing readings

You can store up to 1,000 measurements in the reading memory. 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 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) mode, the instrument does not collect this information by default.

Changing the instrument from Local to Remote does NOT clear any readings in memory. Changing the instrument from Remote to Local DOEs clear any readings in memory.

In general, you turn the reading of measurements on and off by pressing [Run/Stop], as described above.

You can also take one reading or a specified number of readings by pressing **[Single]**.
To save readings, press **[Acquire] > Save Readings**. Then use the menu that appears to configure the location where you want to save the readings:




When finish configuring reading storage, press **Done** > **Save Readings** to save the readings in memory to a file.

## Clearing Reading Memory

**The following actions clear reading memory:**

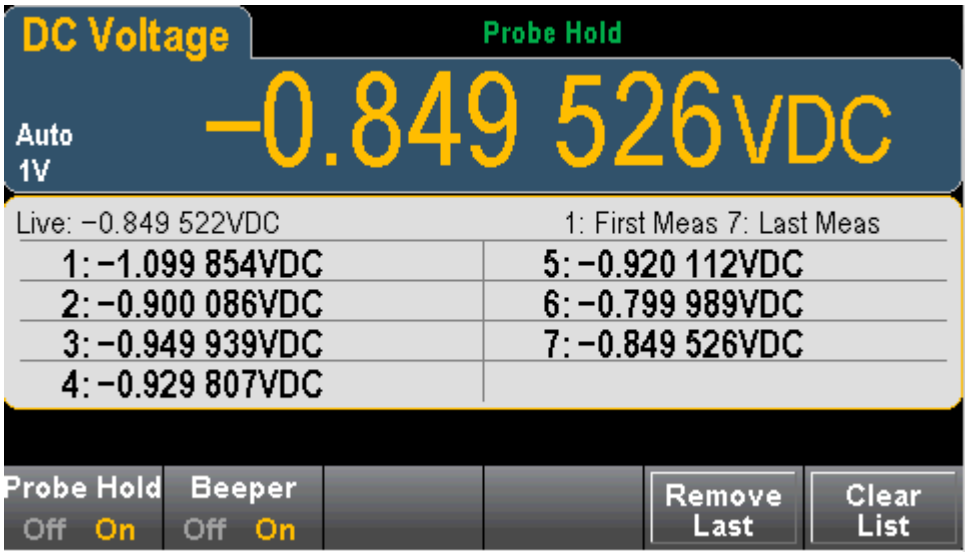
- Changing the measurement function
- Pressing any **Clear Readings** softkey
- Transitioning in or out of Probe Hold
- Changing temperature units
- Changing any dB/dBm parameters
- Changing any histogram binning parameter
- Changing the temperature probe or R0
- Recalling a stored state
- Calibrating the instrument
- Switching between 3 A and 10 A inputs
- Changing the position of the Front/Rear switch
- Turning Null on or off or changing the Null value

**These actions do not clear reading memory:**

- Changing measurement parameters, such as range and aperture.
- Turning limits on or off, or adjusting limit values
- Pressing **[Run/Stop]** in front panel auto trigger mode
- Changing the trend chart **Recent/All** softkey
- Changing samples per trigger or trigger delay
- Changing display modes
- Changing the **VM Comp** output polarity
- Changing the digit mask
- Changing the histogram, bar meter, or trend chart scale
- Changing user preferences
- Executing self-test
- Transferring from Remote to Local mode

## Probe Hold

Because probing small areas requires careful concentration, it is often difficult to read the instrument display while taking measurements. Therefore, the instrument includes a front panel **[Probe Hold]** key that allows you to take readings without viewing the display. You can generate up to eight readings and hold them on the display for later viewing. These readings may be of different measurement types and you may clear displayed readings at any time.




In Probe Hold mode, the instrument optimizes measurement settings to allow reliable detection of stable signals (these settings are restored to their original values when you exit Probe Hold.) When you probe a signal, the instrument beeps (if the beeper is enabled) and automatically records a measurement when it finds a series of stable readings. You may take additional readings without pressing **[Probe Hold]** again.

Press **Remove Last** to remove the last reading from the list. Press **Clear List** to remove all readings from the list.

Because the Probe Hold display is optimized for the Probe Hold readings, you may not combine it with other display modes, such as histogram, bar graph, trend chart, or statistics. Probe Hold is a front panel only function. Readings recorded in Probe Hold mode cannot be accessed from remote. You can, however, take a screen capture of the probe hold display, see Utility Menu - Manage Files for details.

## Math - Introduction

The **[Math]** key is the shifted **[Null]**:




These math functions are available:




- Null
- dB/dBm scaling
- Statistics
- Limits

## Math – Null

A null reading is a value that is subtracted from all subsequent measurements. The value is specific to the present function and will persist even if you leave this function and return to it later.

One common use of this feature is to remove lead resistance from a resistance measurement. To do this, simply short the test leads together and press **[Null]**. For other measurement functions, place the probes across a null value circuit before pressing **[Null]**.

You can also specify a null value by pressing **[Math]**, changing the first softkey to **Value**, and entering the value using the arrow keys. To turn off the null feature, press **[Null]** again or press **[Math]** and set the first softkey to **Off**.



## Math - dB/dBm Scaling

The dB and dBm scaling functions, which apply to ACV and DCV measurements only, allow you to scale measurements relative to a reference value.

NOTE

*Scaling is set to OFF when you change measurement functions (for example, changing from DCV to ACV). You must re-enable scaling after changing measurement functions.*

### Front Panel Menus

The dB and dBm functions are accessed from the second softkey in the **[Math]** menu.




When function is dB:




When function is dBm:




### dB Scaling

Each dB measurement is the difference between the input signal and a stored reference value (both values converted to dBm):

**dB** = reading in dBm - reference value in dBm

The relative value must be from -200 to +200 dBm (default 0). You can either measure this value by pressing **Measure Ref Value**, or you can enter a specified value.

### dBm Scaling

The dBm function is a logarithmic, comparing power delivered to a reference resistance, relative to 1 mW:

**dBm** = 10 x $\log_{10}$ (reading $^2$ / reference resistance / 1 mW)

The reference resistance values (**Ref R**) may be 50, 75, 93, 110, 124, 125,135, 150, 250, 300, 500, 600 (default), 800,900, 1000, 1200 or 8000 Ω. Press **Ref R** and use the up and down arrows keys on the front panel to select.

## Math - Statistics

As the instrument takes measurements, it automatically calculates statistics on those measurements.

### Front Panel Menus

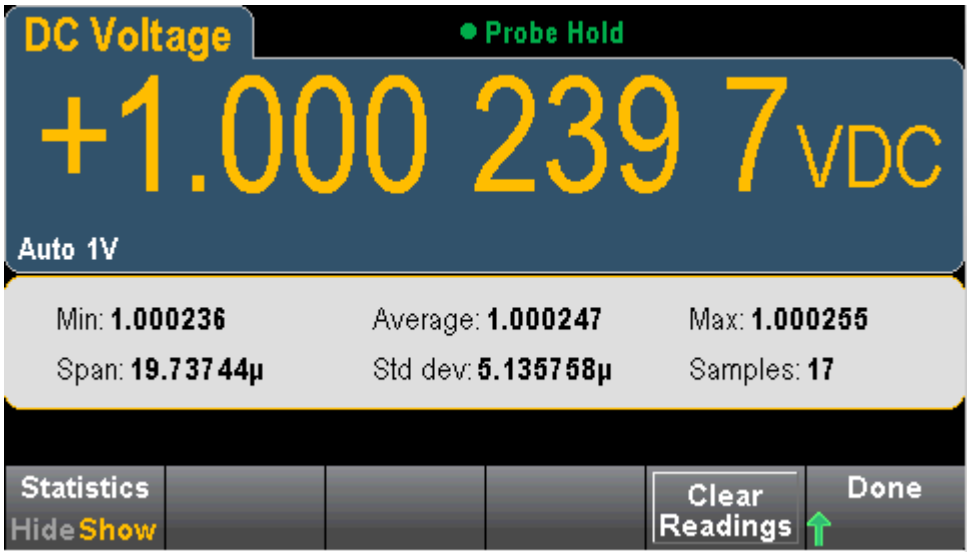
The statistics menu can be accessed from the third softkey in the [Math] menu.




NOTE

*For accurate displayed statistics of AC measurements in front panel mode, the default manual trigger delay (**[Acquire] >Delay Man**) must be used.*

The first softkey on this menu hides or shows the statistics below the data display (number, bar meter, trend chart, or histogram).




If dB or dBm scaling is in use, the average and standard deviation are not shown.

NOTE

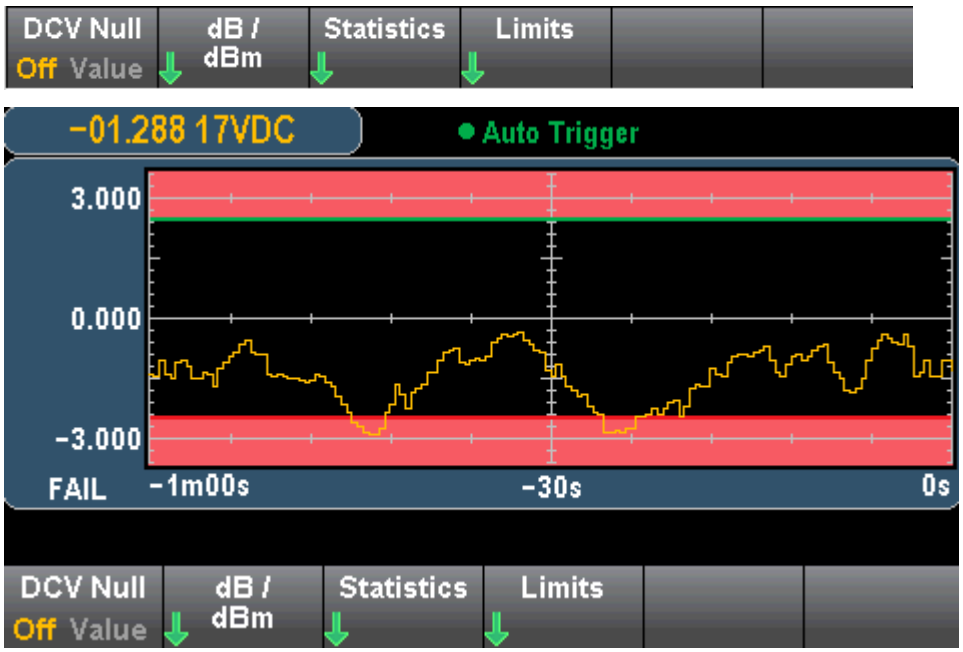
- *The **Span** value is the Max minus the Min.*
- *Press **Clear Readings** to clear reading memory and restart statistics calculation.*

## Math - Limits

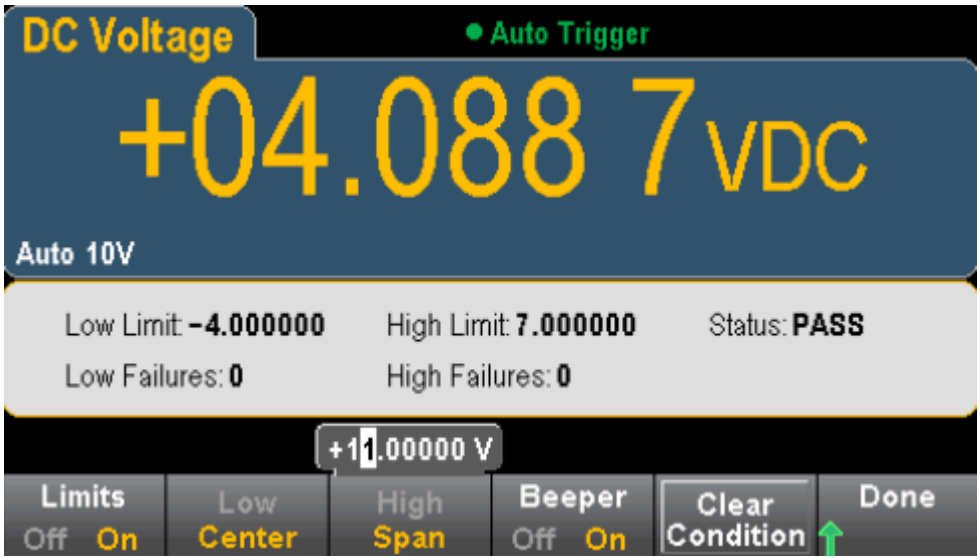
Limit checking indicates how many samples have exceeded specified limits and visually indicates when the limits are exceeded.

### Front Panel Menus

The limits menu is accessed from the **[Math]** menu.




The first softkey enables or disables limits. The second and third softkeys specify the limits either as high and low values or as a span around a center value. For example, a **Low** limit of -4 V and a **High** limit of +7 V are equivalent to a **Center** of 1.5 V and a **Span** of 11 V.

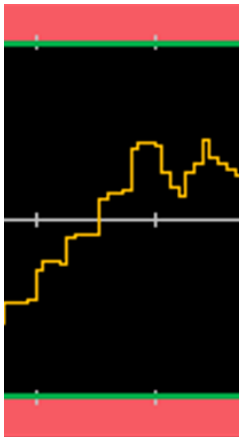


The **Beeper** softkey enables or disables beeping when limits are violated (this also enables or disables the beeper for the other functions that use the beeper - probe hold, diode, continuity, and errors. **Clear Condition** resets the limit borders to green, as described below.

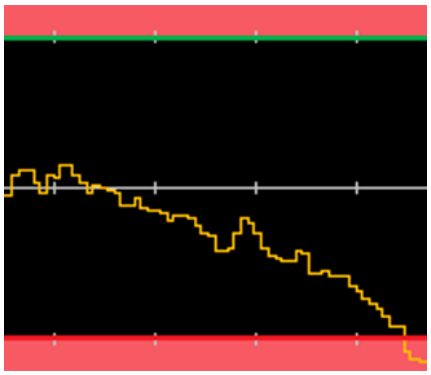
## Limit Indications

The display uses colors to indicate limits and limit violations.

**Trend Chart**
The limit area is shown in light red on the graph. The limit borders are green (shown below) as long as the limits have not been exceeded.

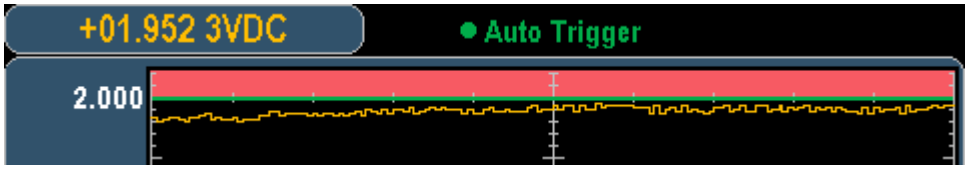


When a limit is exceeded, the border turns red. In the image below, the top border is still green, but the bottom border has changed to red because the trend line has gone into the lower limit area.

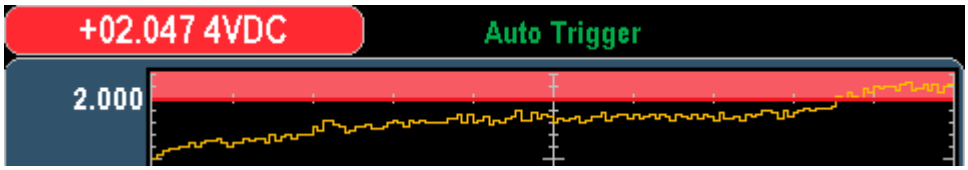


The border will remain red even if the trend line moves out of the limit area. When the trend line is within limits, you can reset the borders to green by pressing **Clear Condition**.

Note also that the number of the newest measurement displayed, +01.9523 VDC below, indicates whether the measurement is within limits. Because the limit is 2 V, the 1.9523 VDC value is shown with the standard background.

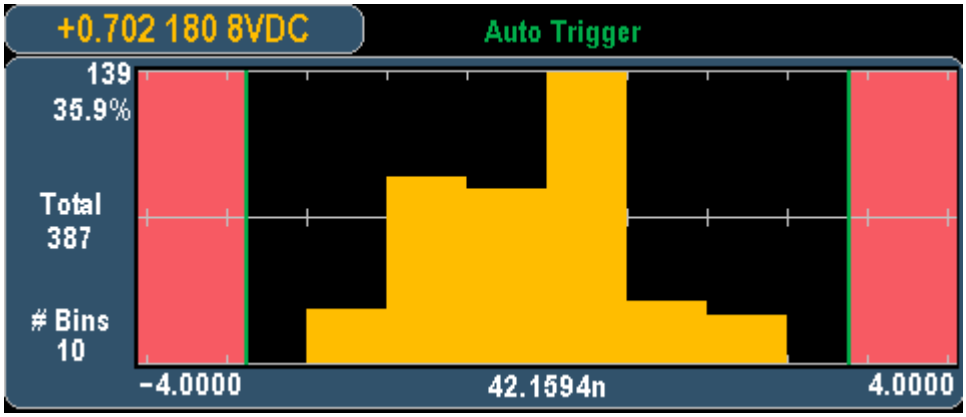



In contrast, the 2.0474 VDC reading is highlighted in red to indicate that it is outside the limits.

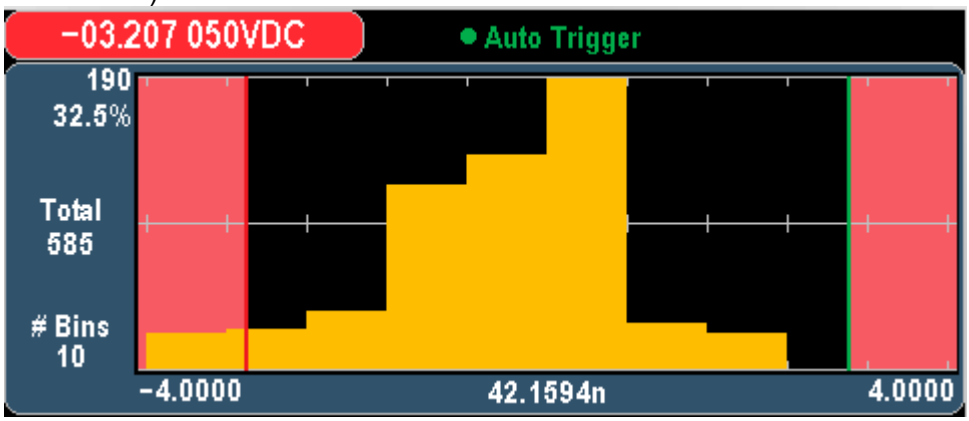



**Histogram**

The same color scheme applies to histograms. In the image below, the green vertical lines that separate the black histogram background from the light red limit areas indicate that limits have not been exceeded.

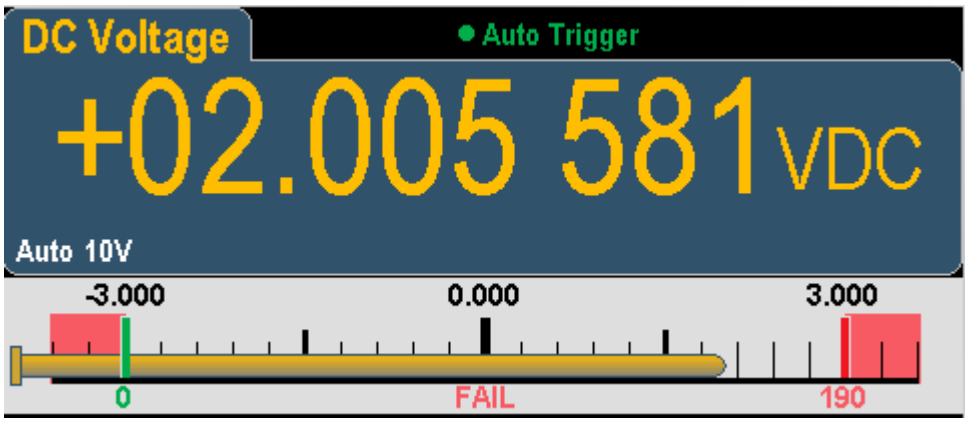



In the image below, the lower (left) limit border is red, indicating that the lower limit has been exceeded. (The reading in the upper left corner (-01.68487 VDC) is within limits, so it is not red.)



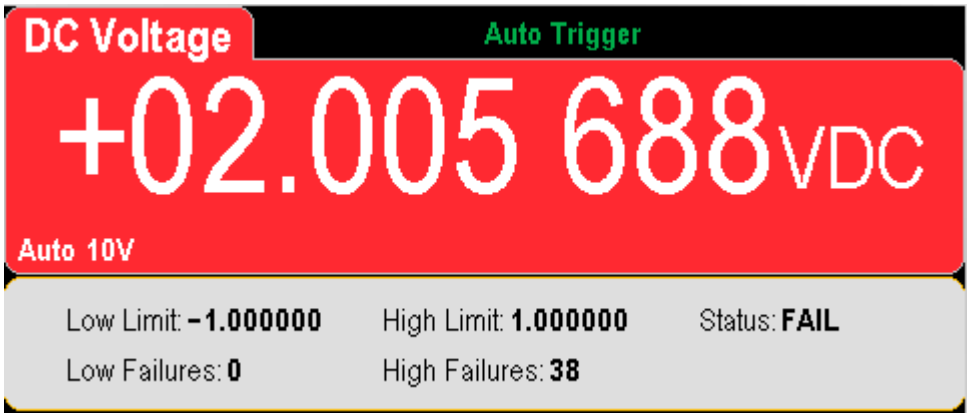
**Bar Meter**

The bar meter (below) uses the same color scheme. The green limit border on the left indicates that the lower limit has not been exceeded, and the red limit border on the right indicates that the upper limit has been exceeded. The numbers 0 and 86 below the light red limit areas indicate how many times each limit has been exceeded, and the word FAIL indicates that a limit has been exceeded.



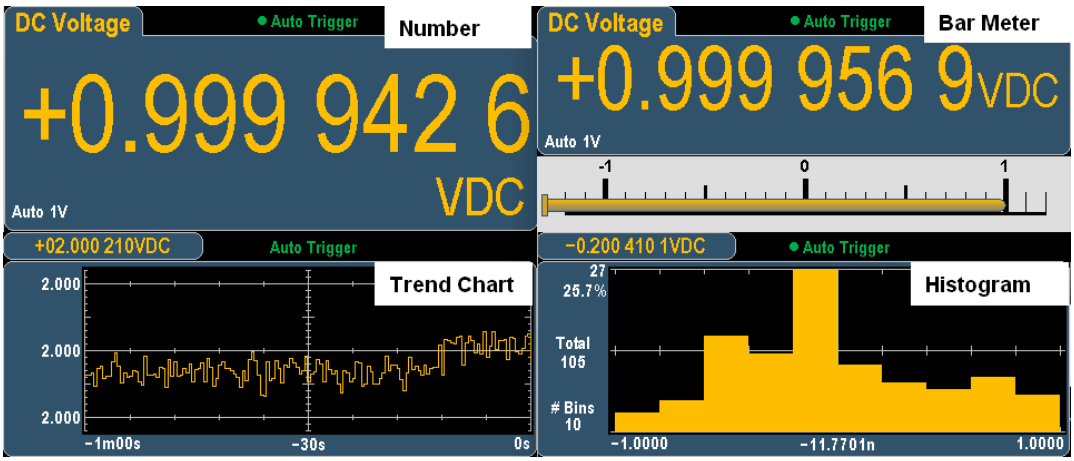

**Number**

The bright red color (shown below) indicates that the displayed measurement exceeds the limits.
The **Number** display also indicates how many times the limits have been exceeded.



# Display - Introduction

By default, the instrument displays readings as a number. You can also select a bar meter, trend chart or histogram display:




For the number and bar meter displays, many primary measurement functions allow you to display a secondary measurement.

## Selecting the Display

Press the 

key, and then press the Display softkey to select the display type:

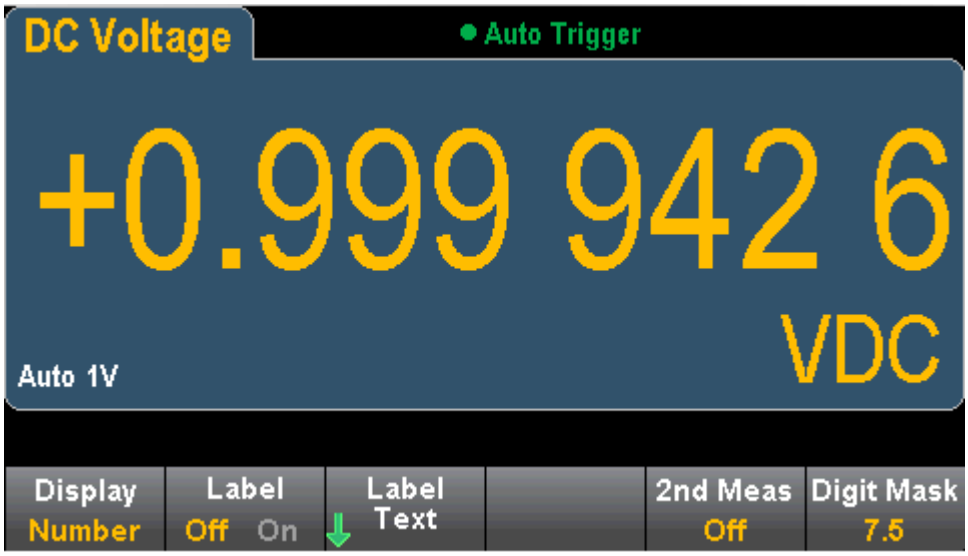



The following table summarizes all display types for continuous mode.

| Display Type | | | | Comments/Uses |
|---|---|---|---|---|
| Number | Bar Meter | Trend Chart | Histogram | |
| Power on default, present measurement on display. | Number + bar graph, present measurement on display. | Measurement spanning a specified amount of time, and display as strip chart (trend), or histogram. Exact measurement values not accessible from front panel. | | Trend and histogram data are displayed only, individual reading values not available from front panel. |

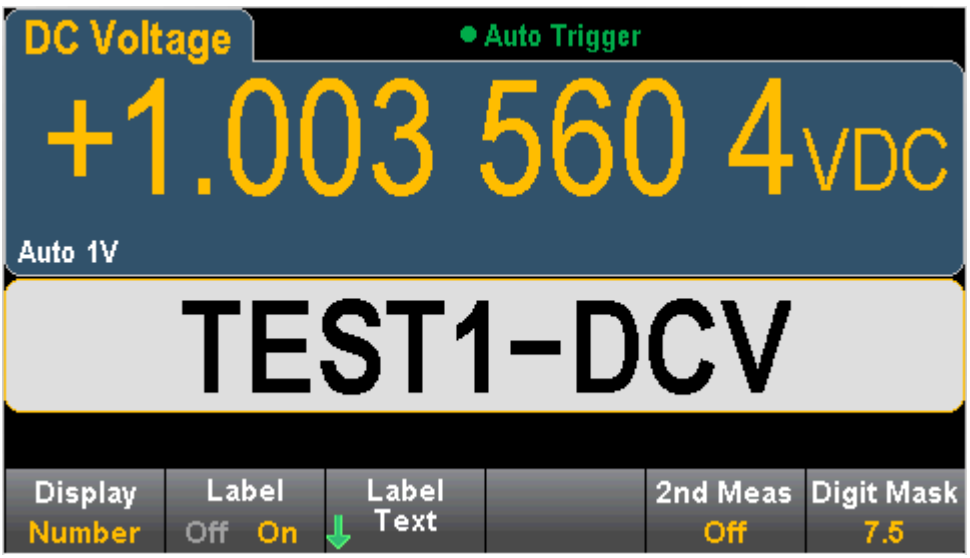
### Number

By default, the instrument displays readings as a number:

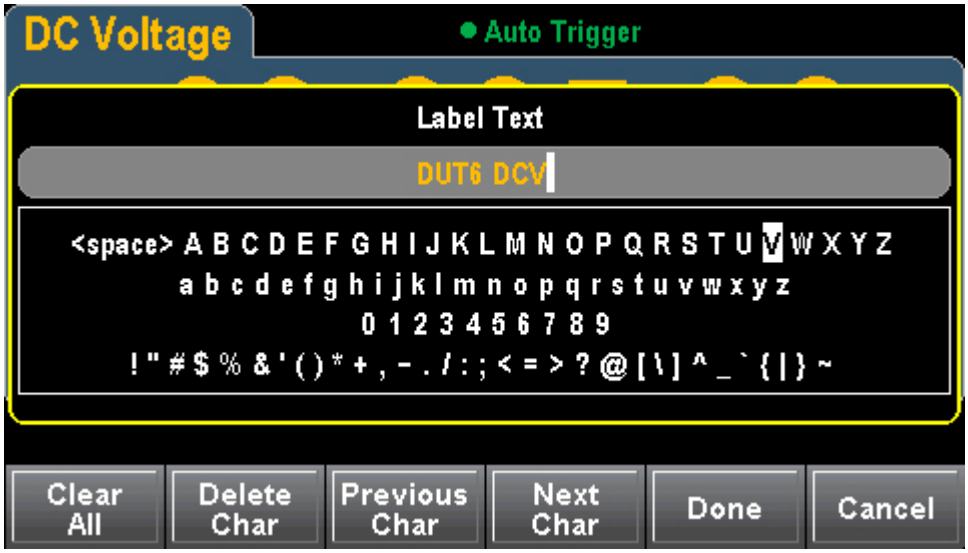



#### Adding a Label

The **Label** softkey allows you to add a large text label to the screen. For example, you can use this to indicate what measurement is being taken by the DMM.

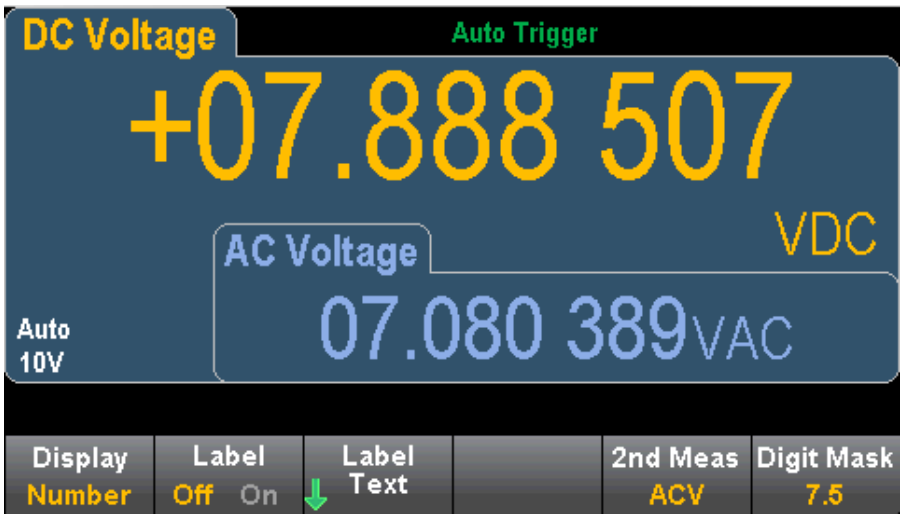



To enter the text, press **Label Text** and use the softkeys and front panel arrow keys to modify the label (below). Then press **Done**. The label's font automatically shrinks to accommodate longer labels.




**Selecting a Secondary Measurement**

Press 2nd Meas to select and display a secondary measurement. For example, for the DCV measurement function, you can select ACV, Peak, or Pre-Math as the secondary measurement function. With ACV selected as secondary, the display shows the DCV measurement near to top of the display, and the ACV measurement near the bottom of the display:



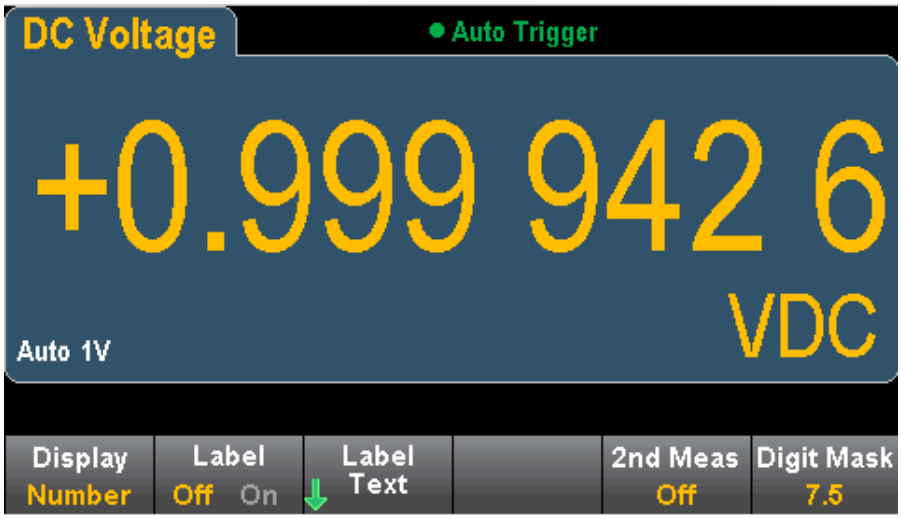

For more information on secondary measurements available for each measurement function, refer to the **Secondary Measurements** section.

### Specifying the Digit Masking

The Digit Mask softkey specifies the number of digits shown.




For example, the following image shows 7.5 digits.



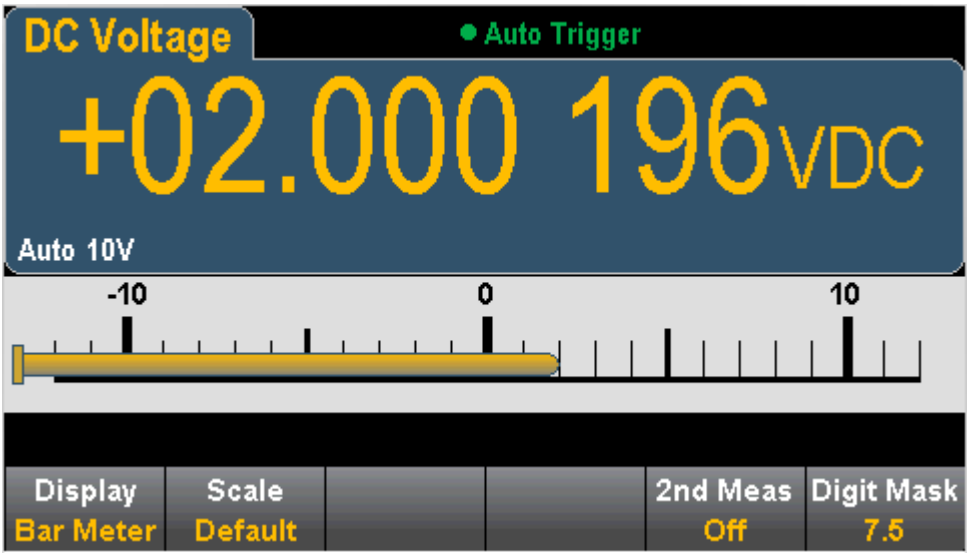

In contrast, this image shows 4.5 digits.



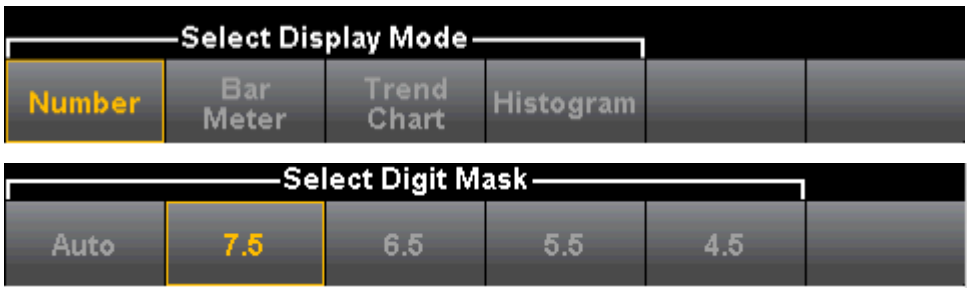

The **Auto** softkey specifies that the number of digits displayed is based on other function-specific settings, such as the measurement aperture, set in NPLCs. Measurements are always rounded, never truncated.

## Bar Meter

The bar meter (below) adds a moving bar below the standard Number display.




The **Display** and **Digit Mask** softkeys behave as they do in the Number display.




The **Scale** softkey specifies the horizontal scale:

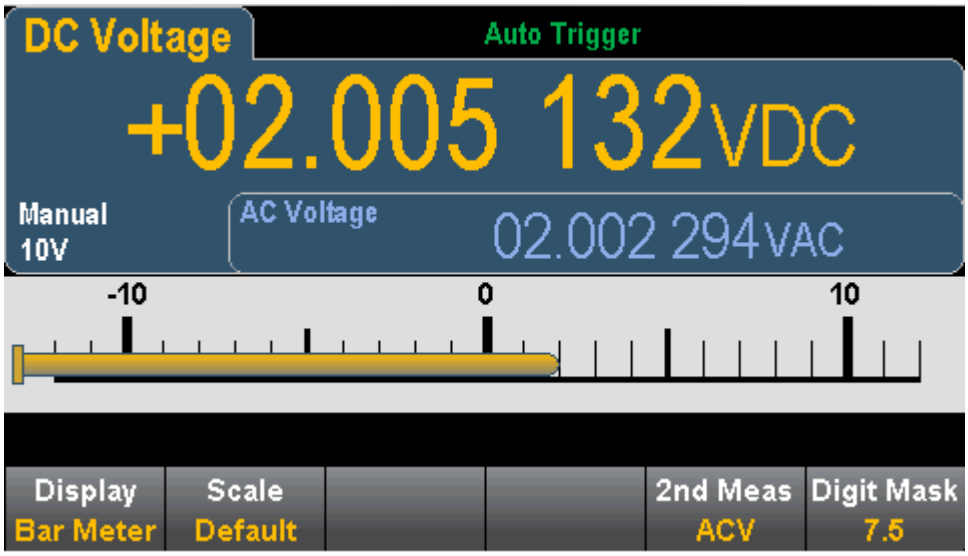



- **Default** sets the scale to equal the measurement range.
- **Manual** allows you to configure the scale either as **High** and **Low** values or as a **Span** around a **Center** value. For example, a scale that goes from a **Low** of -500 Ω to a **High** of 1000 Ω could also be specified as a **Center** of 250 Ω with a **Span** of 1500 Ω.



**Selecting a Secondary Measurement**

Press **2nd Meas** to select and display a secondary measurement. For example, for the DCV measurement function, you can select ACV, Peak, or Pre-Math as the secondary measurement function. With ACV selected as secondary, the display shows the DCV measurement as a number near to top of the display, DCV in the bar meter, and the ACV measurement above the bar meter:

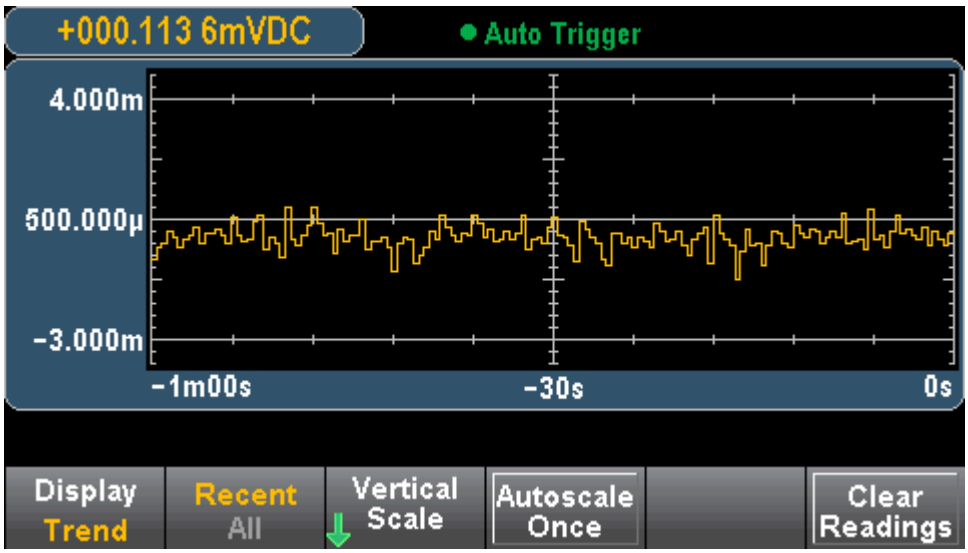


## Trend Chart (Continuous Measurement Mode)

To select the trend chart, press **[Display]** followed by the **Display** softkey:




In the Continuous measurement mode, the trend chart shows data trends over time:




## Recent/All

The Recent/All softkey shows either all of the data in the trend chart (All) or just the most recent data (Recent). Neither selection clears reading memory.
In All mode, the trend chart displays all readings being taken and builds from left to right. After the display is filled, the data becomes compressed on the left side of the display as new data is added on the right side of the display.

## Scaling

The **Vertical Scale** softkey specifies how the current vertical scale is determined.



Press **Vertical** to change the scaling:




- **Default** sets the scale to equal the measurement range.
- **Auto** automatically adjusts the scale to appropriately fit the line currently shown on the screen.
- **Manual** allows you to configure the scale either as **High** and **Low** values or as a **Span** around a **Center** value. For example, a scale from a **Low** of 0 V to a **High** of 5 V is equivalent to a **Center** of 2.5 V and a **Span** of 5 V.

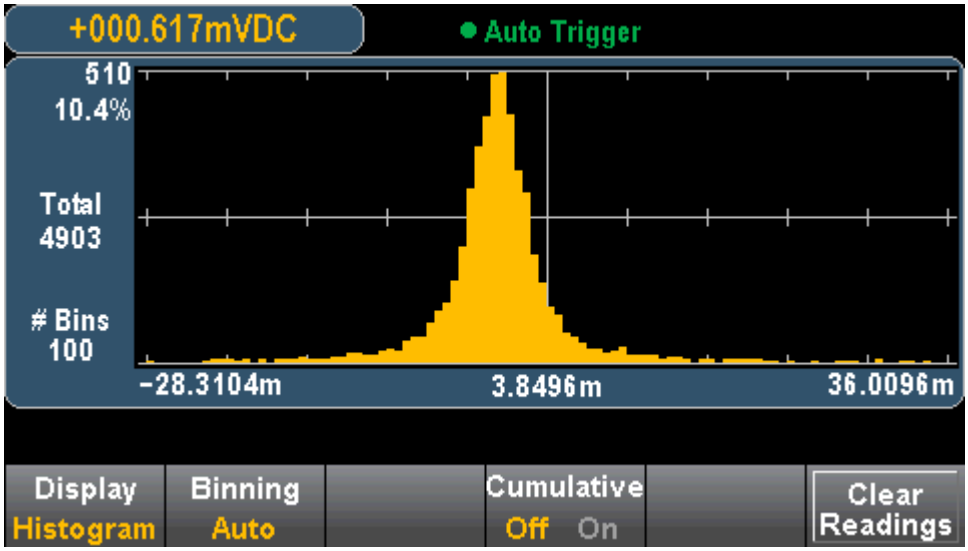



If you have enabled Limits, the **Limits** softkey also appears. This sets the vertical scale to match the limits.



## Histogram

The histogram shows measurement data as a graphical representation of the distribution of measurement data. Data is grouped in bins represented by vertical bars in the histogram display.




NOTE

*Autoranging can adversely affect the histogram display when measuring repetitive signals spanning multiple ranges. To avoid this, select a fixed range when using the histogram display.*

### Select the display

Press the 

key, and then press the **Display** softkey to select the display type:




### Binning

The **Binning** softkey allows you to either let the instrument control how the histogram is binned (automatic binning), or to manually specify the binning parameters with the **Bin Settings** softkey.

Changing any binning parameter, or switching between automatic and manual binning, will automatically start the histogram over with new data.



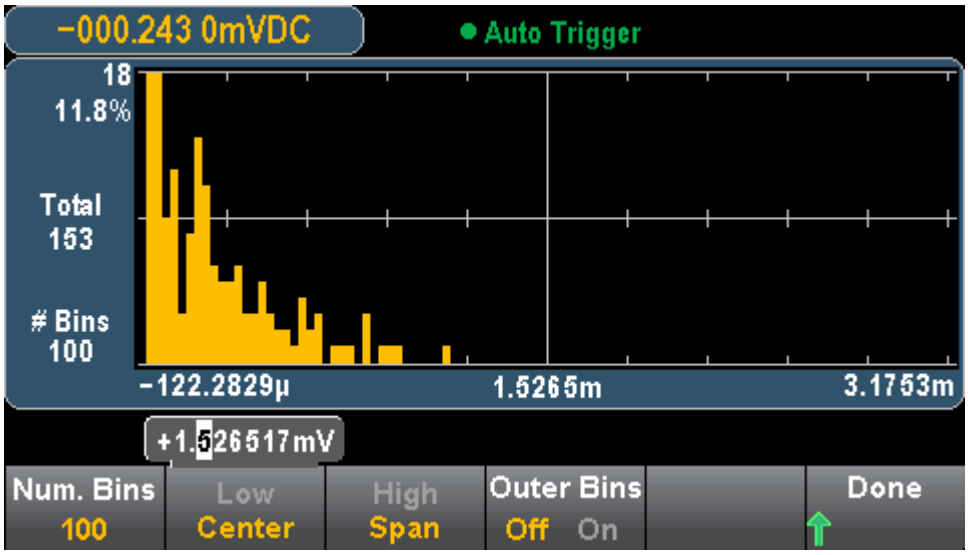

For **Binning Auto**, the algorithm starts by continuously readjusting the histogram span based on the readings coming in, completely re-binning the data whenever a new value comes in outside of the current span. After acquiring a large number of readings, a new reading outside of the range causes the bins to be compressed by a factor of two such that the new bin range will cover the new reading. The number of bins shown is a function of the number of readings received: 0 to 100 readings = 10 bins, 101 to 500 readings =20 bins, 501 to 1000 readings = 40 bins, 1001 to 5000 readings = 100 bins, 5001 to 10000 readings = 200 bins, >10000 readings = 400 bins.

If the NPLC setting is < 1 PLC, the maximum number of bins is 100.

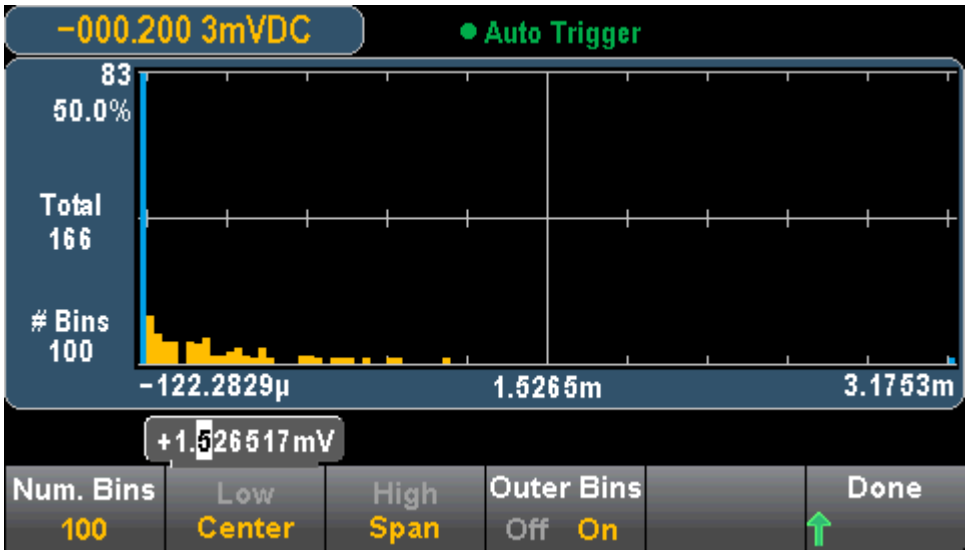
For **Binning Manual,** you can set the bins number to 10, 20, 40, 100, 200, or 400. You can specify the bin range as either **Low** and **High** values, or as a **Span** around a **Center** value. For example, the histogram range shown above (from -5 to 4 V) could be specified as a **Low** of -5 V and a **High of** 4 V, or a **Center** of -0.5 V and a **Span** of 9 V.

The **Outer Bins** softkey displays two additional bins, for readings above and below the bin range.

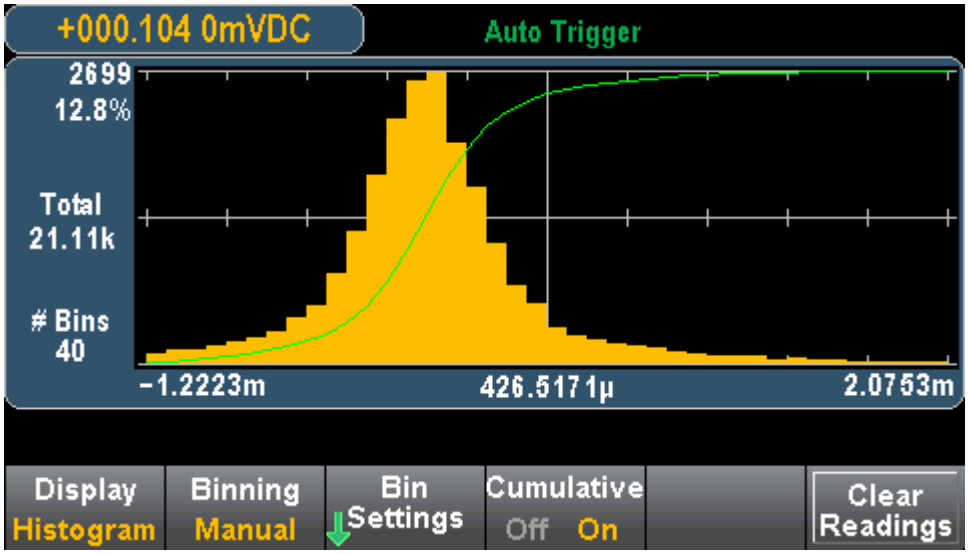
For example, this image shows the **Outer Bins** softkey set to **Off**.



The image below adds the outer bins to the display. The relatively large number of readings above the bin range (the cyan bar) causes the bars within the bin range to shrink.




The main histogram menu includes a **Cumulative** softkey that hides or shows a line representing the cumulative distribution of the histogram data. Note that this line represents all of the data only when the outer bins are shown; if the outer bins are not shown, the outer bin data is not represented in the line. The cumulative distribution line always goes from 0 to 100% on the vertical scale, regardless of the histogram's scale.

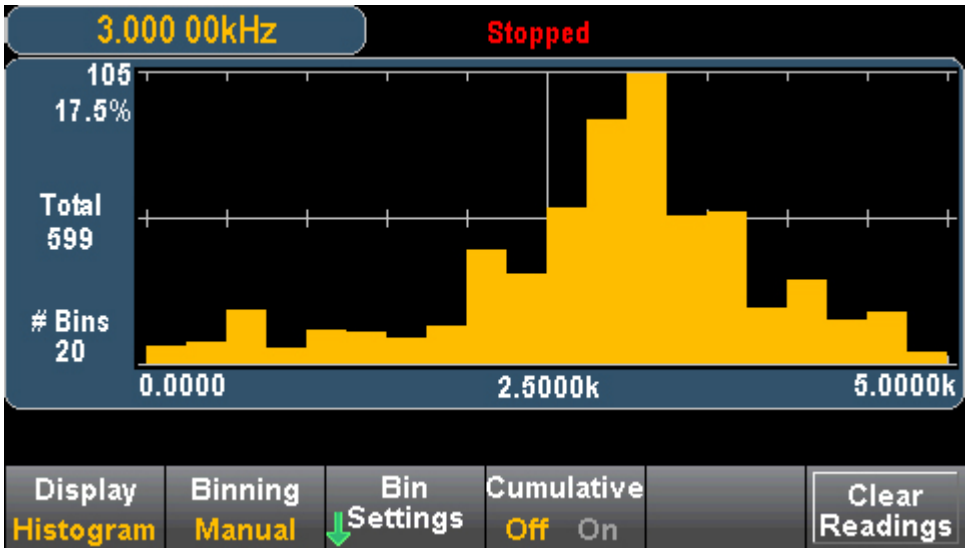



The final button on the histogram menu, **Clear Readings**, clears reading memory and starts a new histogram.

### Histogram Data

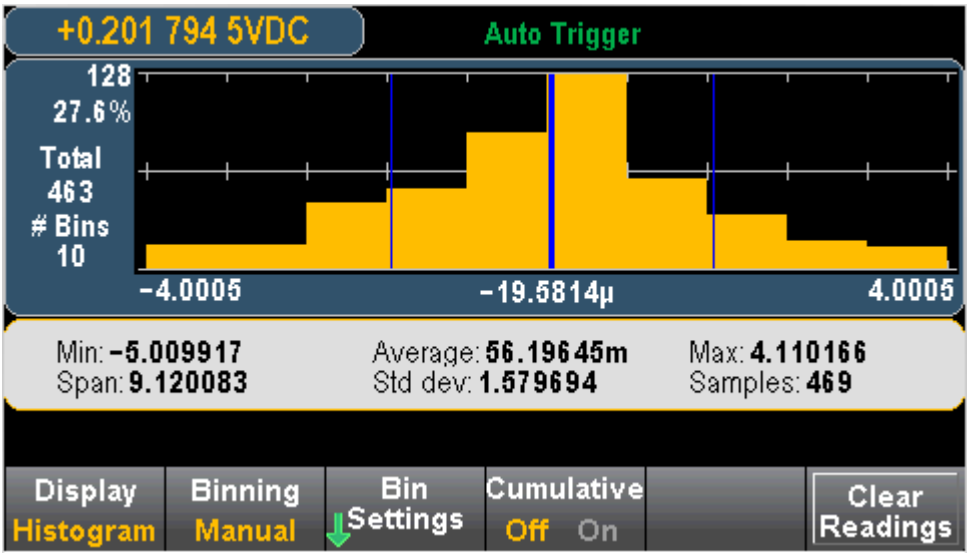
The graphic below shows a histogram of frequency measurements. Data is displayed on the left side of the histogram. In the graphic below, reading from top left downward:

- **3.00000 kHz** - present measurement value.
- **105** - Number of samples in the largest bin.
- **17.5%** - Percentage of samples in the largest bin.
- **Total 599** - Total number of samples.
- **# Bins 20** - Total number of bins.
- **0, 2.5k, 5k** - (Below the histogram) Range of frequency values.




### Histogram with Statistics

Showing statistics (**Shift > Math > Statistics**) is particularly useful for the histogram display. For example, in the graphic below, the thick blue line is the average, and each thin blue line represents one standard deviation from the average.



# Utility Menu - Introduction

The **[Utility]** key is the shifted **[Display]** key:




**[Utility]** provides the following features:

Store and Recall State and Preference Files

Manage files, including creating screen shots

Configure LAN (optional on HDM3065B), GPIB (optional on HDM3065H), and SCPI

Perform instrument self-tests and firmware update functions

Configure the instrument's date and time and various user settings

## Utility - Store and Recall State and Preference Files

The Utility menu is shown below.

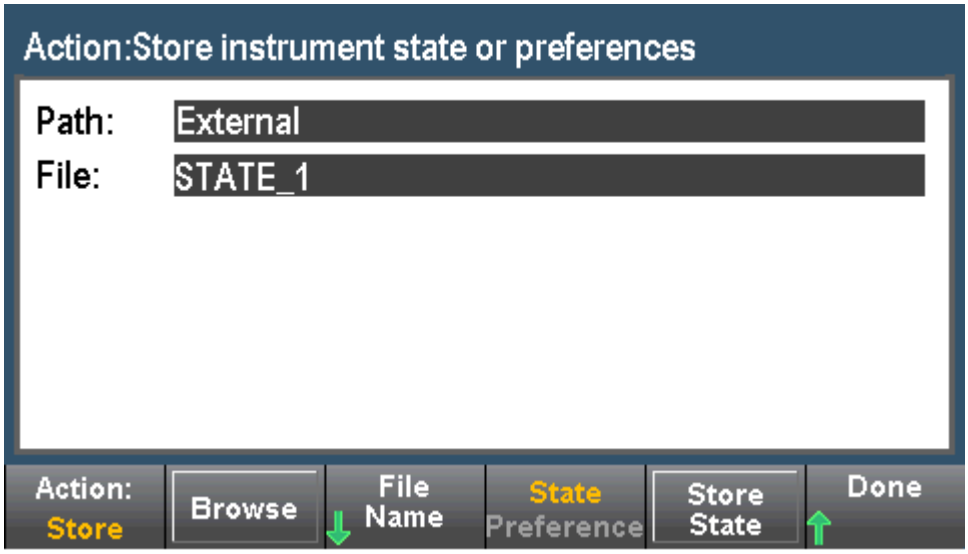



Press **Store/Recall** to save and recall state and preference files. In general, state files store volatile settings associated with measurements. Preferences are non-volatile parameters associated with the instrument, but not any specific measurement.




### Store Settings

**Store Settings** allows you to browse to a directory and specify a file name, and to choose whether you want to store a state file or a preference file.

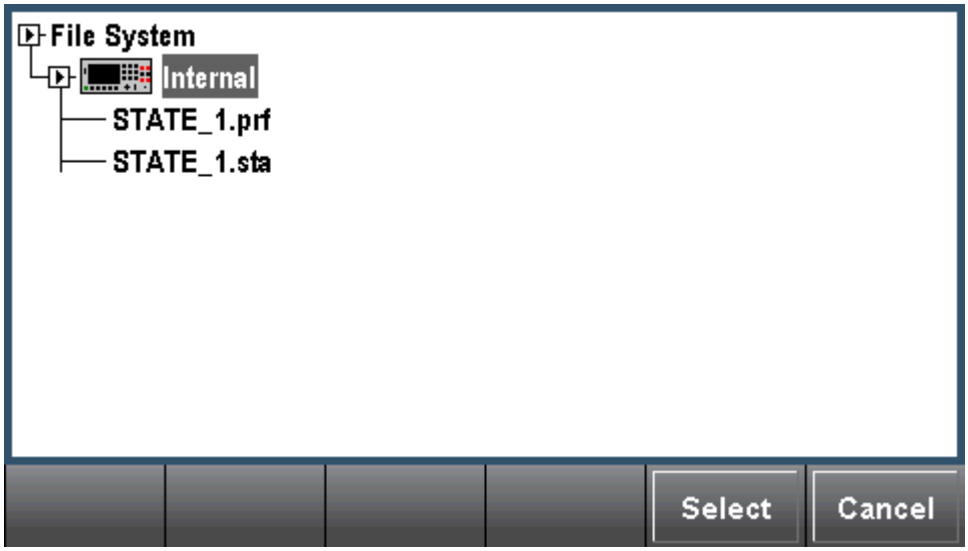


Press **State Preference** to select whether you want to store a state or preferences file, and press **Store State** (shown above) or **Store Pref** (the softkey's label if you are storing preferences) to store the specified file.
**Action** allows you to either store a file or to create a new folder.




### Recall Settings

**Recall Settings** allows you to browse to the file to be recalled. Use the arrow keys to navigate to the desired state file (*.sta) or preferences file (*.prf).




### Power On

**Power On** selects the state that is loaded at power-up. This can be either the state when the instrument was powered down with the power switch (**Last**), a user-selected state file (**User Defined**), or the factory default state (**Factory Defaults**).



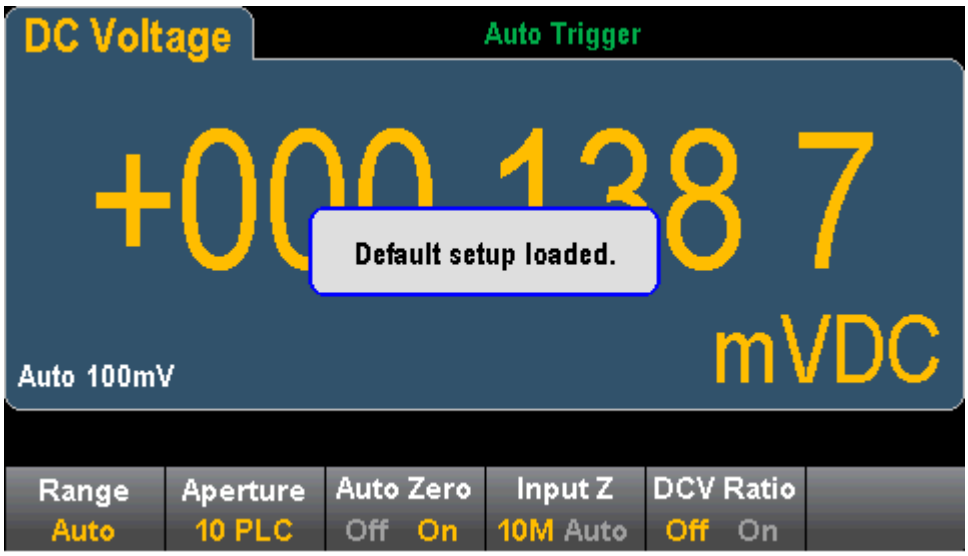

### Set to Defaults

There are two ways to defaults.

1 Press **Set to Defaults** softkey loads the instrument's factory default state.



2 Press the Preset/Default key **P** on the left upper side of the front to load the instrument's default state.



## Utility Menu - Manage Files




The **Manage Files** softkey allows you to create, copy, delete, and rename files and folders in the instrument's internal flash memory or on a USB drive attached to the front panel. It also allows you to capture the current screen to either a bitmap (*.bmp) or portable network graphics (*.png) file.
This is the default option, as shown below.




### Action

**Action** specifies the action to perform. Pressing **Capture Display** saves a screen capture of the display at the moment that you pressed **[Shift]** to go to the **[Utility]** menu.




**Delete** - To delete a file or folder, press **Delete** and **Browse** to the folder or file to delete. Press **Select** > **Perform Delete** > **Done**.

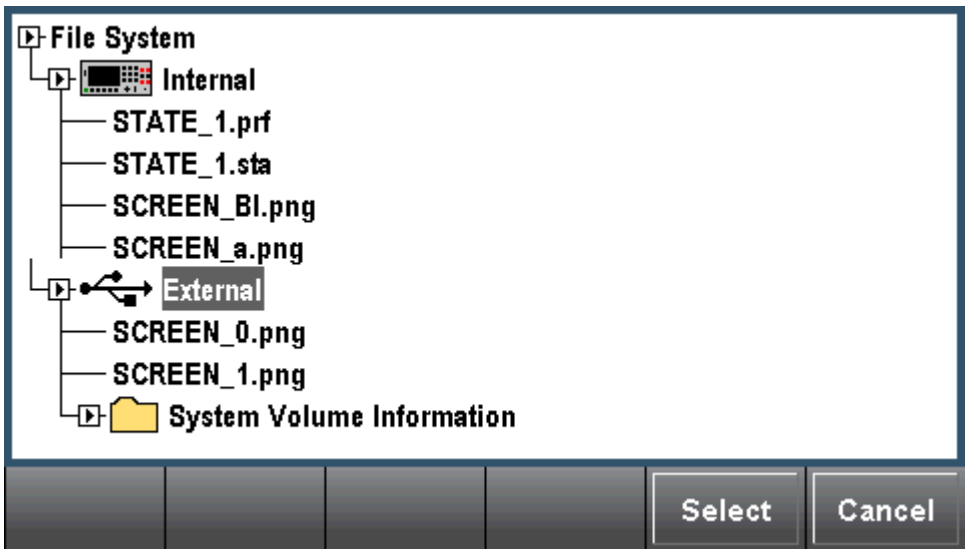
**Folder** - To create a folder, **Browse** to the internal or external location for the folder, press **File Name**, enter a folder name and press **Done**. Press **Create Folder** > **Done**.

**Copy** - To copy a file or folder, press **Copy**. **Browse** to the folder or file to be copied and press **Select**. Press **Copy Path** and select an internal or external path for copying. Press **Perform Copy** > **Done**.

**Rename** - To rename a file or folder, press **Rename**. **Browse** to the folder or file to be renamed and press **Select**. Press **New Name**, enter a new name and press **Done**. Press **Perform Rename** > **Done**.

### Browse

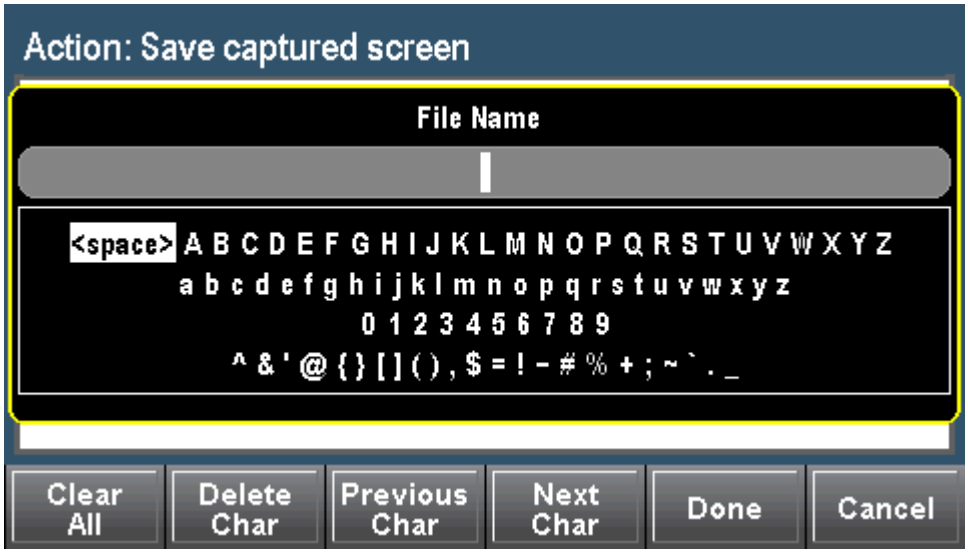
**Browse** selects the file or folder upon which the action will be performed.




Use the front panel arrows and **[OK]** key to navigate through the list, and press **Select** or **Cancel** to exit the browse window. The left and right arrows contract or expand a folder to hide or show its files.

### File Name

**File Name** allows you to use the front panel arrows, the **[OK]** key, and the softkeys to enter a file name. Use the front panel arrows to point to a letter, and **Previous Char** and **Next Char** to move the cursor in the area where the name is entered.

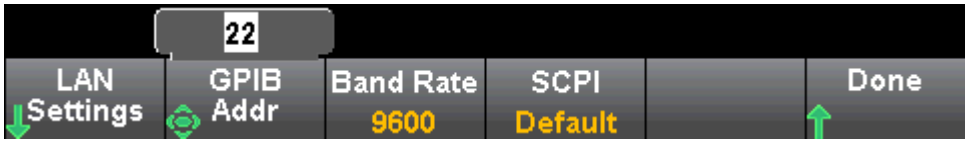



Press **[Done]** or **[Cancel]** to finish.

## Utility Menu - I/O Configuration




**I/O Config** configures the I/O parameters for remote operations over the LAN, USB interface.




### LAN Settings

**LAN Settings** opens the menu shown below.




**IP Mode** enables DHCP or Static assignment of the instrument's IP address. It also enables configuration of network parameters based on the protocol (DHCP or Static) selected.

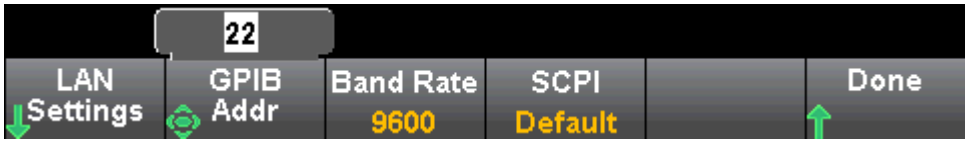



After enabling/disabling one or more services, press **Apply**. After that, you must cycle the instrument power for the new settings to take effect.

### GPIB Settings (optional)

#### GPIB Address

You can set GPIB address to a value from 2 to 30. After changing the address, cycle instrument power for the change to take effect.




### SCPI

You can remotely program the instrument with SCPI over the options below.



## Utility Menu - Test/Admin




**Test/Admin** provides access to self-test, calibration, and firmware update function:




### Self-Test

**Self-Test** verifies proper instrument operation. See Self-Test Procedures for details, and always safely disconnect inputs to the DMM terminals before running the Self Test.

### Calibrate

**Calibrate** access to the instrument calibration procedure. See Calibration for details.




### Firmware Update

**Firmware Update** updates the instrument firmware to a new version. See Firmware Update for details.

## Utility Menu - System Setup




**System Setup** configures user preferences and sets the date and time.




### User Settings

**User Settings** specify user preferences that control how you interact with the instrument. These settings are stored in non-volatile memory and can be saved in a preference (.prf) file.




### Sounds




Disables or enables the click heard when a front panel key or softkey is pressed.

Also enables or disables the audible tone (**Beeper On** or **Off**) associated with the following features:

- Limits – a measurement limit is exceeded (if limits are enabled)
- Probe Hold – the measured signal records a stable reading
- Diode – the forward bias voltage is between 0.3 and 0.8 V
- Continuity – a short is measured (less than or equal to 10 Ω)
- Error - an error is generated from the front panel or remote interface

This non-volatile setting appears in several different menus on the front panel. Turning the beeper on or off in one menu affects all of the other menus and functions. For example, turning the beeper off for probe hold, also turns the beeper off for limits, diode, continuity, and errors.

### Display Options

**Display Options** configure the display.

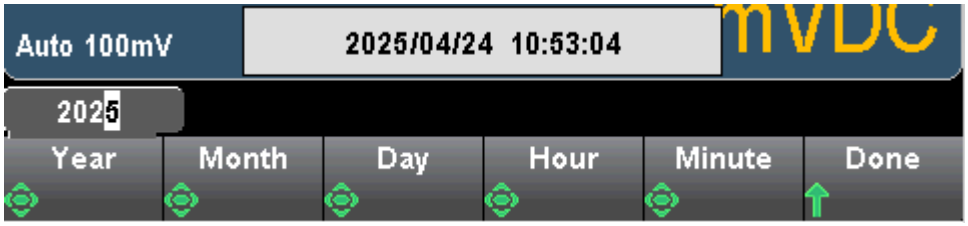



You can enable or disable the display, adjust the brightness (1 to 100%). If you turn off the display, press any front panel key to turn it on again.

**Date / Time**

**Date / Time** sets the instrument's real-time clock, which always uses a 24-hour format (00:00:00 to 23:59:59). There is no automatic setting of the date and time, such as to adjust for daylight savings time.

Use the front panel arrow keys to set the year, month, day, hour, and minute.



# Chapter 4 Measurement Guidance

To achieve the greatest accuracy with the KM 3700 multimeters, you must eliminate potential measurement errors. This chapter describes common errors and suggests ways to avoid them.

- ✧ DC Measurement Considerations
- ✧ Noise Rejection
- ✧ Resistance Measurement Considerations
- ✧ True RMS AC Measurements
- ✧ Capacitance

# DC Measurement Considerations

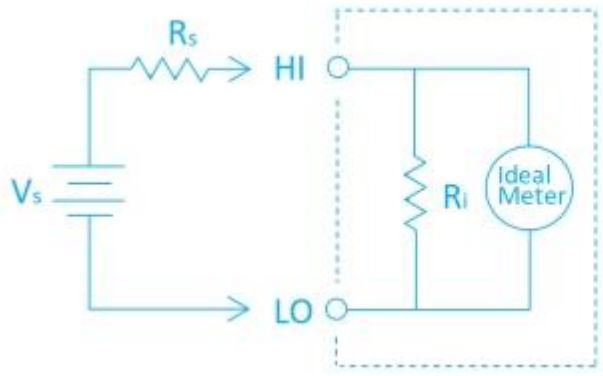
## Thermal EMF Errors

Thermoelectric voltages are the most common error source in low–level DC voltage measurements.
Thermoelectric voltages are generated by circuit connections using dissimilar metals at different temperatures.
Each metal–to–metal junction forms a thermocouple that generates a voltage proportional to the junction temperature, as shown in the table below. You should minimize thermocouple voltages and temperature variations in low–level voltage measurements. The best connections use copper–to–copper crimped connections, as the DMM's input terminals are a copper alloy.

| Copper to | Approximate µV / °C |
|---|---|
| **Cadmium-Tin Solder** | 0.2 |
| **Copper** | <0.3 |
| **Gold** | 0.5 |
| **Silver** | 0.5 |
| **Brass** | 3 |
| **Beryllium Copper** | 5 |
| **Aluminum** | 5 |
| **Tin-Lead Solder** | 5 |
| **Kovar or Alloy 42** | 40 |
| **Silicon** | 500 |
| **Copper Oxide** | 1000 |

## Loading Errors (DC Voltage)

Measurement loading errors occur when the resistance of the DUT is an appreciable percentage of the multimeter's input resistance, as shown below.




$V_s$ = ideal DUT voltage
$R_s$ = DUT source resistance
$R_i$ = multimeter input resistance (10MΩ or > 10GΩ)

$$\text{Error (\%)} = \frac{100 \times R_s}{R_s + R_i}$$

To reduce the effects of loading errors and to minimize noise pickup, set the multimeter's input resistance to >10 GΩ (high impedance) for the 100 mVDC, 1 VDC, and 10 VDC ranges. The input resistance is maintained at 10 MΩ for the 100 VDC and 1000 VDC ranges.

# Noise Rejection

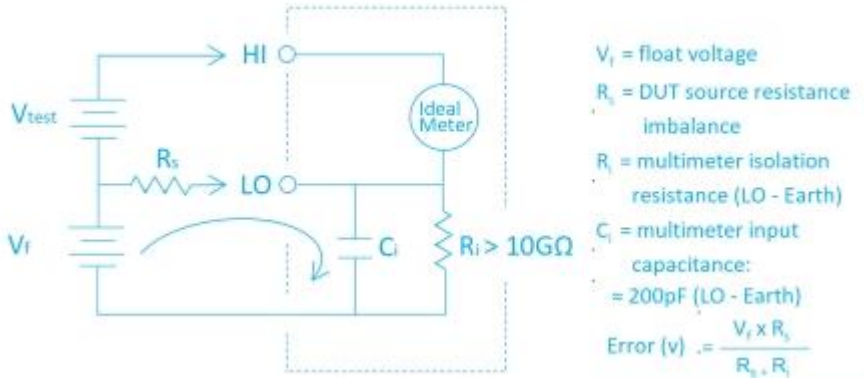
## Rejecting Power - Line Noise Voltages

A desirable characteristic of integrating analog–to–digital (A/D) converters is their ability to reject power– line related noise present with DC input signals. This is called normal mode noise rejection, or NMR. The multimeter achieves NMR by measuring the average DC input by "integrating" it over a fixed period. If you set the integration time to a whole number of power line cycles (PLCs), these errors (and their harmonics) will average out to approximately zero.

The multimeter provides three integration selections (1, 10, and 100 PLCs) that achieve NMR. The multimeter measures the power–line frequency (50 Hz or 60 Hz) and then determines the corresponding integration time. For a complete listing of NMR, approximate added rms noise, reading rate, and resolution for each integration setting, see the Performance vs. Integration Time table.

## Common Mode Rejection (CMR)

Ideally, a multimeter is completely isolated from earth–referenced circuits. However, there is finite resistance between the multimeter's input LO terminal and earth ground, as shown below. This can cause errors when measuring low voltages which are floating relative to earth ground.

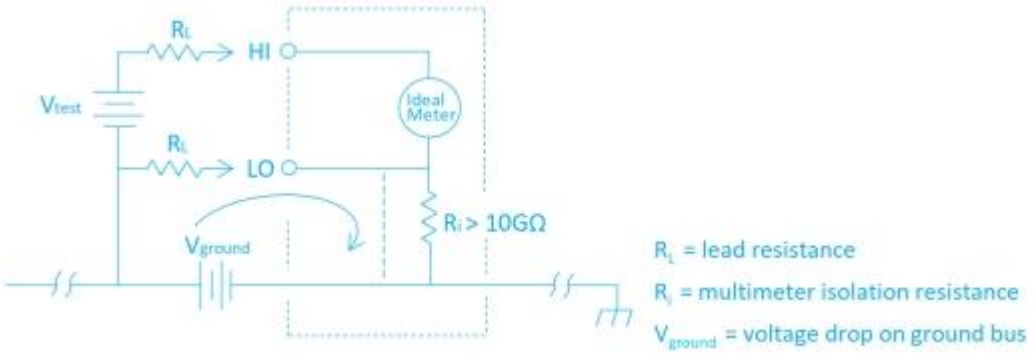



## Noise Caused by Magnetic Loops

When making measurements near magnetic fields, avoid inducing voltages in the measurement connections. You should be especially careful when working near conductors carrying large currents.
Use twisted–pair connections to the multimeter to reduce the noise pickup loop area, or dress the test leads as close together as possible. Loose or vibrating test leads will also induce error voltages.
Tie down test leads securely when operating near magnetic fields. Whenever possible, use magnetic shielding materials or increase distance from magnetic sources.

## Noise Caused by Ground Loops

When measuring voltages in circuits where the multimeter and the DUT are referenced to a common earth ground, a "ground loop" is formed. As shown below, any voltage difference between the two ground reference points (Vground) causes current to flow through the measurement leads. This causes noise and offset voltage (usually power–line related), which are added to the measured voltage.




The best way to eliminate ground loops is to isolate the multimeter from earth by not grounding the input terminals. If the multimeter must be earth–referenced, connect it and the DUT to one common ground point. Also connect the multimeter and DUT to the same electrical outlet whenever possible.

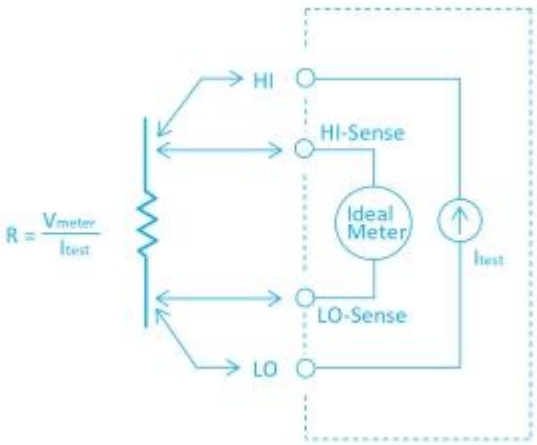
## Resistance Measurement Considerations

The multimeter offers two resistance measurements: 2-wire and 4-wire ohms. For both methods, the test current flows from the input HI terminal, through the resistor being measured. For 2-wire ohms, the voltage drop across the resistor being measured is sensed internal to the multimeter. Therefore, test lead resistance is also measured. For 4-wire ohms, separate "sense" connections are required. Because no current flows in the sense leads, the resistance in these leads does not give a measurement error.

NOTE

*The errors mentioned earlier in this chapter for DC voltage measurements also apply to resistance measurements. Additional error sources unique to resistance measurements are discussed below.*

The 4-wire ohms method provides the most accurate way to measure small resistances because it reduces test lead and contact resistance. This is often used in automated test applications where resistive and/or long cable, numerous connections, or switches exist between the multimeter and the DUT. The recommended connections for 4-wire ohms measurements are shown below.




### Removing Test Lead Resistance Errors

To eliminate offset errors associated with test lead resistance in 2-wire ohms measurements, follow these steps:

Short the test lead ends together and read the displayed test lead resistance.

Press **Null**. The multimeter will store the test lead resistance as the 2-wire ohms null value, and subtract that value from subsequent measurements.

See also "Null Measurements."

## Minimizing Power Dissipation Effects

When measuring resistors designed for temperature measurements (or other resistive devices with large temperature coefficients), be aware that the multimeter will dissipate some power in the DUT. The following table shows several examples.

| Rang | Standard Test Current | Power Dissipation in DUT |
|---|---|---|
| **1 GΩ** | 500 nA | 2.5 µW |
| **100 MΩ** | 500 nA | 2.5 µW |
| **10 MΩ** | 500 nA | 2.5 µW |
| **1 MΩ** | 5 µA | 25 µW |
| **100 kΩ** | 10 µA | 10 µW |
| **10 kΩ** | 100 µA | 100 µW |
| **1 kΩ** | 1 mA | 1 mA |
| **100 Ω** | 1 mA | 100 µW |

If power dissipation is a problem, you should select a higher fixed range (all multimeter models). The low power mode sources less test current per measurement range than is normally sourced for standard resistance measurements, to reduce power dissipation and self-heating in the DUT. The following table shows the various resistance ranges, the standard test current delivered for 2- and 4-wire resistance measurements, and the low power mode test current.

| Rang | Standard Test Current | Low Power Mode Test Current |
|---|---|---|
| **1 GΩ** | 500 nA | 500 nA |
| **100 MΩ** | 500 nA | 500 nA |
| **10 MΩ** | 500 nA | 500 nA |
| **1 MΩ** | 5 µA | 5 µA |
| **100 kΩ** | 10 µA | 5 µA |
| **10 kΩ** | 100 µA | 10 µA |
| **1 kΩ** | 1 mA | 100 µA |
| **100 Ω** | 1 mA | 100 µA |

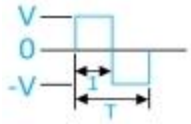
## Errors in High Resistance Measurements

When you are measuring large resistances, significant errors can occur due to insulation resistance and surface cleanliness. You should take the necessary precautions to maintain a "clean" high – resistance system.
Test leads and fixtures are susceptible to leakage due to moisture absorption in insulating materials and "dirty" surface films. Nylon and PVC are relatively poor insulators ($10^9$ Ω) when compared to PTFE insulators ($10^{13}$ Ω). Leakage from nylon or PVC insulators can easily contribute a 0.1% error when measuring a 1 MΩ resistance in humid conditions.

## True RMS AC Measurements

True rms responding multimeters, like the KM 3700, measure the "heating" potential of an applied voltage. Power dissipated in a resistor is proportional to the square of an applied voltage, independent of the waveshape of the signal. This multimeter accurately measures true rms voltage or current, as long as the wave shape contains negligible energy above the meter's effective bandwidth.

The KM 3700 uses the same techniques to measure true rms voltage and true rms current. The effective AC voltage bandwidth is 300 kHz, while the effective AC current bandwidth is 10 kHz.

| Wave Shape | Crest Factor (C.F.) | AC RMS | AC + DC RMS |
|---|---|---|---|
|  | √2 | $\frac{V}{\sqrt{2}}$ | $\frac{V}{\sqrt{2}}$ |
|  | √3 | $\frac{V}{\sqrt{3}}$ | $\frac{V}{\sqrt{3}}$ |
|  | 1 | $\frac{V}{C.F.}$ | $\frac{V}{C.F.}$ |

The DMM's AC voltage and AC current functions measure the AC-coupled true rms value. In this DMM, the "heating value" of only the AC components of the input waveform are measured (dc is rejected). As seen in the figure above; for sine waves, triangle waves, and square waves, the AC-coupled and AC+DC values are equal, because these waveforms do not contain a DC offset.

However, for non-symmetrical waveforms (such as pulse trains) there is a DC voltage content, which is rejected by the AC-coupled true rms measurements. This can provide a significant benefit.

An AC-coupled true rms measurement is desirable when you are measuring small AC signals in the presence of large DC offsets. For example, this situation is common when measuring AC ripple present on DC power supplies. There are situations, however, where you might want to know the AC+DC true rms value.

You can determine this value by combining results from DC and AC measurements, as shown below:

$RMS_{(AC+DC)} = \sqrt{AC^2 + DC^2}$

For the best AC noise rejection, you should perform the DC measurement using an integration time of at least 10 power-line cycles (PLCs).

## True RMS Accuracy and High-Frequency Signal Content

A common misconception is that because an AC multimeter is true rms, its sine wave accuracy specifications apply to all waveforms. Actually, the shape of the input signal dramatically affects measurement accuracy for any multimeter, especially when that input signal contains high-frequency the instrument's bandwidth.

For example, consider a pulse train, one of the most challenging waveforms for a multimeter. The pulse width of that waveform largely determines its high–frequency content. The frequency spectrum of an individual pulse is determined by its Fourier Integral. The frequency spectrum of the pulse train is the Fourier Series that samples along the Fourier Integral at multiples of the input pulse repetition frequency (prf).

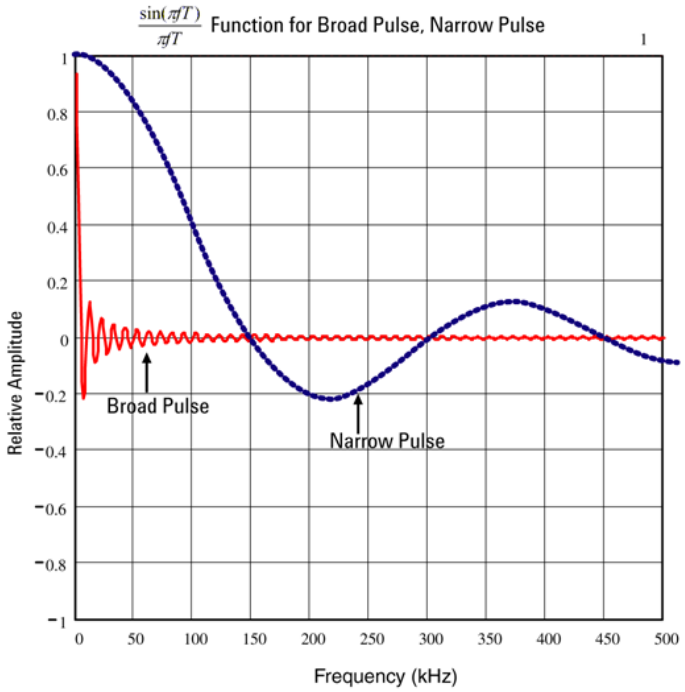
The figure below shows the Fourier Integral of two very different pulses: one of broad width (200 µs); the other narrow (6.7 µs). The bandwidth of the ACV path in the DMM is 300 kHz; therefore, frequency content above 300 kHz is not measured.

Notice that the sin(πfT)/ πfT spectrum of the narrow pulse significantly exceeds the effective bandwidth of the instrument. The net result is a less accurate measurement of the narrow, high-frequency pulse.

In contrast, the frequency spectrum of the broad pulse has fallen off significantly below the multimeter's 300 kHz (approximately) bandwidth, so measurements of this pulse are more accurate.

Reducing the prf increases the density of lines in the Fourier spectrum, and increases the portion of the input signal's spectral energy within the multimeter's bandwidth, which improves accuracy.

In summary, errors in rms measurements arise when there is significant input signal energy at frequencies above the multimeter's bandwidth.



## Estimating High-Frequency (Out-of-Band) Error

A common way to describe signal waveshapes is to refer to their "Crest Factor". Crest factor is the ratio of the peak value to rms value of a waveform. For a pulse train, for example, the crest factor is approximately equal to the square root of the inverse of the duty cycle.

$$CF = \frac{1}{\sqrt{d}} = \frac{1}{\sqrt{\frac{t_p}{T}}} = \frac{1}{\sqrt{prf \times t_p}}$$

Notice that crest factor is a composite parameter, dependent upon the pulse width and repetition frequency; crest factor alone is not enough to characterize the frequency content of a signal.

Traditionally, DMMs include a crest factor derating table that applies at all frequencies. The measurement algorithm used in the DMMs is not inherently sensitive to crest factor, so no such derating is necessary. With this multimeter, as discussed in the previous section, the focal issue is high-frequency signal content which exceeds the multimeter's bandwidth.

For periodic signals, the combination of crest factor and repetition rate can suggest the amount of high-frequency content and associated measurement error. The first zero crossing of a simple pulse occurs at $f_1 = 1/t_p$.

This gives an immediate impression of the high-frequency content by identifying where this crossing occurs as a function of crest factor: $f_1=(CF^2)(prf)$.

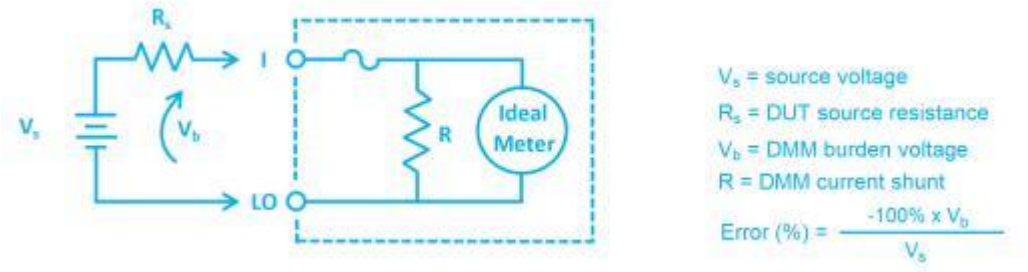
# Other Primary Measurement Functions

## Frequency and Period Measurement Errors

The multimeter uses a reciprocal counting technique to measure frequency and period. This method generates constant measurement resolution for any input frequency. The multimeter's AC voltage measurement section performs input signal conditioning. All frequency counters are susceptible to errors when measuring low-voltage, low-frequency signals. The effects of both internal noise and external noise pickup are critical when measuring "slow" signals. The error is inversely proportional to frequency. Measurement errors also occur if you attempt to measure the frequency (or period) of an input following a DC offset voltage change. You must allow the multimeter's input DC blocking capacitor to fully settle before making frequency measurements.

## DC Current

When you connect the multimeter in series with a test circuit to measure current, a measurement error is introduced. The error is caused by the multimeter's series burden voltage. A voltage is developed across the wiring resistance and current shunt resistance of the multimeter, as shown below.




### Avoid applying signals to unused current input terminals

If signal inputs are applied to terminals not needed for the current measurement, measurement errors may occur. The unused terminals are still protected but the un-needed signals may interfere with current measurement. For example, applying inputs to the 3A terminals while making measurements on the 10A terminals will typically cause errors.

The Hi and Lo sense terminals are not used for many measurements. Applying signals here when not needed can also cause errors. AC or DC voltages above 15 volts peak on the un-needed sense terminals are likely to cause measurement errors. If unexpected errors are occurring, signals on the un-needed terminals is an area to check.

### Temperature Measurements

Temperature measurements require a temperature transducer probe. The supported probes are 2-wire and 4-wire RTDs, 2-wire and 4-wire thermistors.

**Probe Type Choice**
RTD's provide very accurate, highly linear relationships between resistance and temperature, over a range of roughly -200 to 500 °C. There is very little conversion complexity for an RTD because it is so intrinsically linear. The multimeter provides measurement for the IEC751 standard RTD, which has a sensitivity of 0.385%/°C.

**Thermistor Requirements**

The DMM converts the measured thermistor resistance to temperature using the Steinhart-Hart thermistor equation:
$1/T = A + B (Ln(R)) + C (Ln(R))^3$
Where:
A, B, and C are constants provided by the thermistor manufacturer and derived from three temperature test points.
R = Thermistor resistance in Ω.
T = Temperature in degrees K.

**Important:** Use only a 5 kΩ 44007-type thermistor. This type thermistor has constants of A = 1.285e-3, B = 2.362e-4, C = 9.285e-8. Using an incorrect type of thermistor can result in errors greater than 20 °C for a temperature being measured of 100 °C.

**2-Wire vs. 4-Wire Measurements**

As with resistance measurements, 4-wire temperature measurements are more accurate, because errors due to lead wire resistance are completely eliminated. Alternatively, you can use the multimeter's Null function to remove the test lead resistance from the measurement (see NULL Reading below).

## NULL Reading

The DMM allows a separate null setting to be saved for the temperature function. When making null measurements, each reading is the difference between a stored null value and the input signal.
One application of NULL is to increase accuracy of two-wire resistance measurements by first nulling the closed–circuit test lead resistance.

## Autozero On/Off

Enabling the autozero feature (ON) provides greater accuracy; however, the additional measurement (of zero) reduces the reading speed.

## Making High-Speed AC Measurements

The multimeter's AC voltage and AC current functions implement three low-frequency filters. These filters allow you to trade-off minimum measured frequency for faster reading speed. The FAST filter settles in 0.025 seconds and is useful for frequencies above 200 Hz. The MEDIUM filter settles in 0.625 seconds for voltage and 0.25 seconds for current and is useful for measurements above 20 Hz. The SLOW filter settles in 2.5 seconds for voltage and 1.66 seconds for current and is useful for frequencies above 3 Hz.

With a few precautions, you can perform AC measurements at speeds up to 500 readings per second.

Use manual ranging to eliminate auto-ranging delays. By setting the trigger delay to 0, the FAST, MEDIUM, and SLOW filters allow up to 500, 150, and 50 readings per second, but with reduced accuracy because the filter may not fully settle. If the sample-to-sample levels are similar, little settling time is required for each new reading. Under this specialized condition, the MEDIUM filter provides reduced accuracy results at 20 readings per second, and the FAST filter provides reduced accuracy results at 200 readings per second.

| AC Filter | Filter Bandwidth | Settling Time (s) | | Full Settling (rdgs/s) | | Partial Settling | Max. rdgs/s |
|---|---|---|---|---|---|---|---|
| | | ACV | ACI | ACV | ACI | AC/ACI | AC/ACI |
| **Slow** | 3 Hz | 2.5 | 1.67 | 0.4 | 0.6 | 2 | 50 |
| **Medium** | 20 Hz | 0.63 | 0.25 | 1.6 | 4 | 20 | 150 |
| **Fast** | 200 Hz | 0.025 | 0.025 | 40 | 40 | 200 | 500 |

In applications where sample-to-sample levels vary widely, but the DC offset level does not change, the MEDIUM filter settles at 2 to 4 readings per second (depending upon the lowest frequency component in the waveform) as shown in the following table:

| Lowest Frequency Component | 20 Hz | 50 Hz | 100 Hz | 200 Hz |
|---|---|---|---|---|
| **AC Current (allowable rate in rdgs/s)** | 4 | 4 | 4 | 4 |
| **AC Voltage (allowable rate in rdgs/s)** | 2 | 3 | 4 | 4 |

For AC voltage, additional settling time may be required when the DC level varies from sample to sample. The default sample delays allow for a DC level change of 3% of range for all filters. If the DC level change exceeds these levels, additional settling time is required. The multimeter's DC blocking circuitry has a settling time constant of 0.2 seconds. This settling time only affects measurement accuracy when DC offset levels vary from sample to sample. If maximum measurement speed is desired, you may want to add an external DC blocking circuit for circuitry with significant DC voltages present. This circuit can be as simple as a resistor and a capacitor.

For AC current, additional settling time is not required when the DC level varies sample to sample.

## Making High–Speed DC and Resistance Measurements

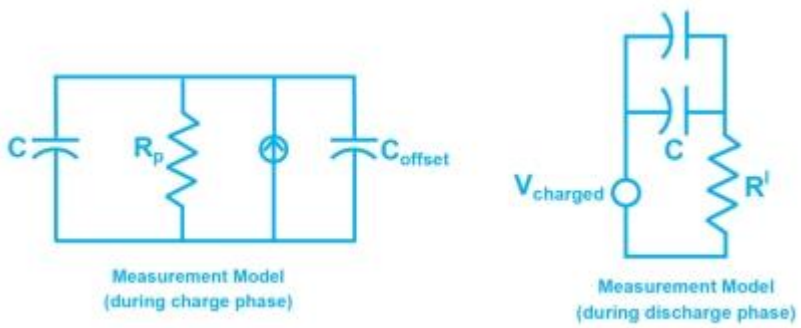
To make the fastest (but least accurate) DC or resistance measurements:

- Set the integration time (NPLC or aperture) to minimum
- Select a fixed range (autorange off)
- Disable autozero
- Disable offset compensation (resistance measurements)

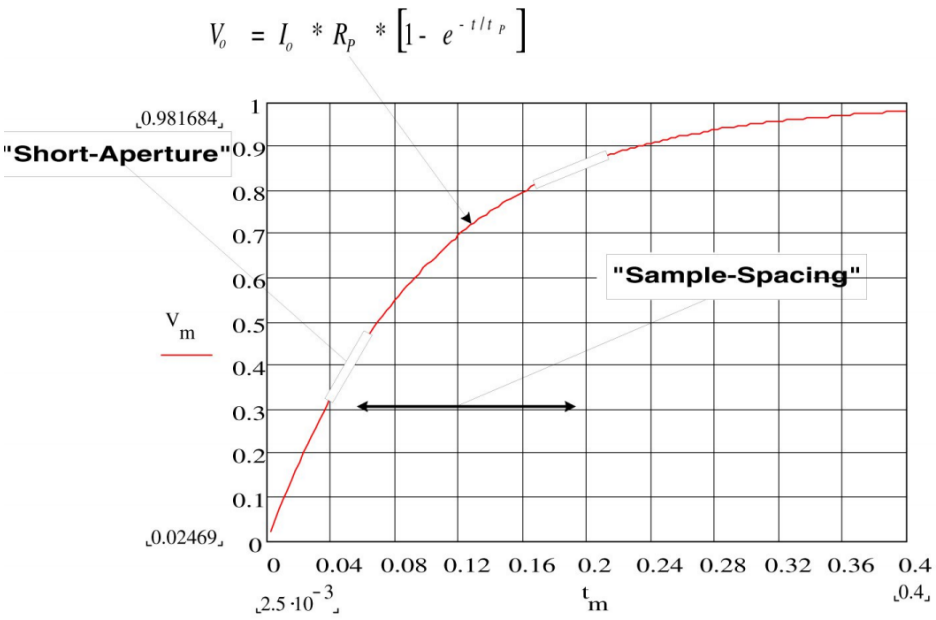
Refer to the particular measurement type in Measurements for more information on the above functions.

# Capacitance

The multimeter makes capacitance measurements by applying a known current to charge the capacitance and then a resistance to discharge as shown below:




An illustration of the response curve while charging as follows:




Capacitance is calculated by measuring the change in voltage (DV) that occurs over a “short aperture” time, (Dt). This measurement is repeated at two different times during the exponential rise that occurs.
An algorithm takes the data from these four points, and by linearizing that exponential rise over these “short apertures”, accurately calculates the capacitance value.
The measurement cycle consists of two parts: a charge phase (shown in the graph) and a discharge phase.
The time-constant during the discharge phase is longer, due to a 100 kΩ protective resistor in the measurement path. This time-constant plays an important role in the resultant reading rate (measurement time). The incremental times (or “sample times”) as well as the width of the “short apertures”, vary by range, in order to minimize noise and increase reading accuracy.

For the best accuracy, take a zero null measurement with open probes, to null out the test lead capacitance, before connecting the probes across the capacitor to be measured (see Capacitance Measurements for details).

## Capacitance Measurement Considerations

Capacitors that have a high dissipation factor or other non-ideal characteristics will affect capacitance measurements. Capacitors with high dissipation factors may exhibit a variance between the measured value using the multimeter versus the single frequency method of some other LCR meters. The single frequency method will also see more variation at different frequencies. For example, some inexpensive capacitance substitution boxes, when measured with the multimeter, are almost 5% different compared to the same capacitance measured with the single frequency method of an LCR meter. The LCR meter will also show different values at different frequencies.

Capacitors with long time constants (dielectric absorption) will result in slow measurement settling time and will take a number of seconds to stabilize. You may see this when first connecting a capacitor or when the delay time to make a measurement is varied. A high-quality film capacitor typically shows the least of this and an electrolytic capacitor the most, with ceramic capacitors typically in between.

# Other Sources of Measurement Error

## Settling Time Effects

The multimeter can insert automatic measurement settling delays. These delays are adequate for resistance measurements with less than 200 pF of combined cable and device capacitance. This is particularly important when measuring resistances above 100 kΩ. Settling due to RC time constant effects can be quite long. Some precision resistors and multi–function calibrators use large parallel capacitors (1000 pF to 0.1 µF) with high resistor values to filter out noise currents injected by their internal circuitry. Non-ideal capacitances in cables and other devices may have much longer settling times than expected just by RC time constants due to dielectric absorption (soak) effects. Errors are measured when settling after the initial connection and after a range change.

## Loading Errors (AC volts)

In the AC voltage function, the input of the multimeter appears as a 1 M? resistance in parallel with 100 pF of capacitance. The cabling that you use to connect signals to the multimeter also adds capacitance and loading.

## Measurements Below Full Scale

You can make the most accurate AC measurements when the multimeter is at or near the full scale of the selected range. Autoranging occurs at 10% (down-range) and 120% (up-range) of full scale.
This enables you to measure some inputs at full scale on one range and 10% of full scale on the next higher range. In general, the accuracy is better on the lower range; for the highest accuracy, select the lowest manual range possible for the measurement.

## AC Current Measurement Errors (Burden Voltage)

Burden voltage errors, which apply to DC current, also apply to AC current measurements. However, the burden voltage for AC current is larger due to the multimeter's series inductance and your measurement connections. The burden voltage increases as the input frequency increases.

Some circuits may oscillate when performing current measurements due to the multimeter's series inductance and your measurement connections.

## Low-Level Measurement Errors

AC voltage measurements less than 100 mV are especially susceptible to errors introduced by extraneous noise sources. An exposed test lead acts as an antenna and a properly functioning DMM will measure the signals received. The entire measurement path, including the power line, acts as a loop antenna. Circulating currents in the loop create error voltages across any impedances in series with the DMM's input. Therefore, you should apply low-level AC voltages to the DMM through shielded cables, with the shield connected to the input LO terminal.

Connect the DMM and the AC source to the same electrical outlet whenever possible. You should also minimize the area of any ground loops that cannot be avoided. A high-impedance source is more susceptible to noise pickup than a low-impedance source. You can reduce the high-frequency impedance of a source by placing a capacitor in parallel with the DMM's input terminals. You may have to experiment to determine the correct capacitor for your application.

Most extraneous noise is not correlated with the input signal. You can determine the error as shown below.

$$\text{Voltage Measured} = \sqrt{V_{in}^2 + \text{Noise}^2}$$

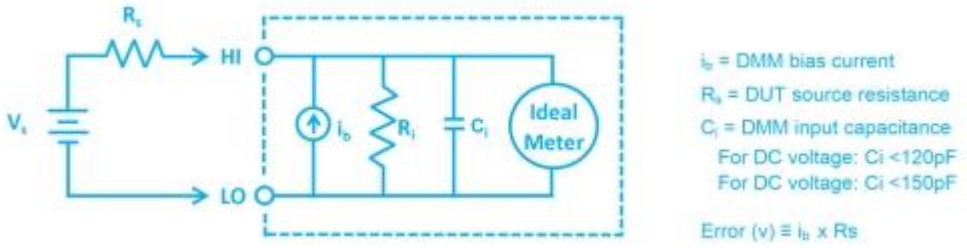
Correlated noise, while rare, is especially detrimental because it always adds directly to the input signal. Measuring a low–level signal with the same frequency as the local power line is a common situation that is prone to this error.

## Common Mode Errors

Errors are generated when the multimeter's input LO terminal is driven with an AC voltage relative to earth. The most common situation where unnecessary common mode voltages are created is when the output of an AC calibrator is connected to the multimeter "backwards." Ideally, a multimeter reads the same regardless of how the source is connected. Both source and multimeter effects can degrade this ideal situation. Because of the capacitance between the input LO terminal and earth (approximately 200 pF), the source will experience different loading depending on how the input is applied. The magnitude of the error is dependent upon the source's response to this loading.
The DMM's measurement circuitry, while extensively shielded, responds differently in the backward input case due to slight differences in stray capacitance to earth. The DMM's errors are greatest for high-voltage, high-frequency inputs. Typically, the DMM exhibits about 0.06% additional error for a 100 V, 100 kHz reverse input. You can use the grounding techniques described for DC common mode problems to minimize AC common mode voltages.

## Leakage Current Errors

The DMM's input capacitance will "charge up" due to input bias currents when the terminals are open-circuited (if the input resistance is >10 GΩ). The DMM's measuring circuitry exhibits approximately 30pA of input bias current for ambient temperatures from 0 to 30 °C. Bias current doubles for every 8 °C change in ambient temperature above 30 °C. This current generates small voltage offsets dependent upon the source resistance of the DUT. This effect becomes evident for a source resistance of greater than 100 kΩ, or when the DMM's operating temperature is significantly greater than 30 °C.




## Unnecessary Signal Errors

Both 3A and 10A terminals are available for AC and DC current measurements. If signals are applied to terminals not being used for the current measurement, measurement errors may occur. The unused terminals are protected but the additional signals may interfere with current measurements.
For example, applying inputs to the 3A terminals while making measurements on the 10A terminals will typically cause errors.
Unnecessary signals applied to the Hi and Lo Sense terminals can also cause errors. AC or DC voltages above 15 volts peak on the sense terminals are likely to cause measurement errors.

## How Sample Rate/Interval is Determined

The DMM always attempts to make the sample interval greater than the expected time required to take measurements. A number of settings go into the calculation of the minimum allowable sample interval. These settings include the measurement function, NPLC, aperture, autorange, autozero, offset compensation, AC filter, TC open check and gate time.

For example, when autorange is on, the assumption is that no more than one range change will be required. If more than one level of change occurs, the measurement may be delayed and an error will be issued.

When you change any of these settings, the sample interval (sample timer in continuous mode) is increased to be greater than the calculated measurement time. In the continuous mode, attempting to reduce the sample interval below the calculated value results in an error message. You must then choose among the various ways you can achieve a smaller measurement time to achieve the smaller sample interval, such as decreasing the NPLC setting.

Another way to put it is that for continuous mode, sample timer/interval is always controlled by the other measurement settings.

# Chapter 5 Repair

This section contains basic instrument repair information.

- ✧ Electrostatic Discharge (ESD) Precautions
- ✧ Troubleshooting
- ✧ Self-Test Procedures
- ✧ User Replaceable Parts
- ✧ Disassembly
- ✧ Battery Replacement
- ✧ 3 A and 10 A Current Path Fuse Replacement

## Electrostatic Discharge (ESD) Precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling.

Component damage can occur at electrostatic discharge voltages as low as 50 V. The following guidelines will help prevent ESD damage during service operations:

- Disassemble instruments only in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.

# Troubleshooting

Before troubleshooting or repairing the instrument, make sure the failure is in the instrument rather than any external connections. Also make sure that the instrument was accurately calibrated within the last year (see Calibration Interval). The instrument's circuits allow troubleshooting and repair with basic test equipment.

**CAUTION**

DO NOT swap the motherboard or the front panel board from one instrument to another.

These boards contain model number and serial number information that uniquely identifies a specific unit, and boards that are mismatched to the instrument may result in problems with its performance or warranty.

## Troubleshooting Procedure

1 Remove all remote I/O connections and front panel connections to the instrument. Verify that:

a. the AC mains power cord is securely connected to the instrument and plugged into a live outlet

b. the front panel Power On/Standby switch has been pushed

2 If the standby light below the power switch is not illuminated, re-verify the items above. If all this is correct, check the AC mains power and then the internal line fuse.

3 Turn the instrument on. If the power-on sequence completes and the display appears to function properly, verify that the instrument is in local mode, and run the self-test (**[Utility] > Test/Admin > Self-Test**). If the display is illegible, replace the front panel board.

**CAUTION**

Ensure that all connections (front and rear) are removed when self-test is performed. During self-test, errors may be induced by signals present on external wiring, such as long test leads that can act as antennas.

4 If the self-test generates an error, record the error code and message and contact Hantek support if necessary.

5 If the self-test does not generate an error:

a. If the measurements are out of specification, you may wish to calibrate the instrument before deciding to replace the main board.

b. If the front panel buttons are not working, make sure the unit is in local mode (the Remote annunciator in the upper right corner of the display is not displayed). If that does not solve the problem, replace the front panel board.

c. If the display is dim, adjust the display intensity.

# Self-Test Procedures

## Power-On Self-Test

Each time the instrument is powered on, it performs a self-test on its real-time clock, keyboard processor, power controller, measurement processor, calibration memory, FPGA, ADC, gain and offset circuitry, and voltage references. You do not need to remove inputs to the instrument to run the test.

## Full Self-Test

A complete self-test takes approximately two seconds. This tests all of the items tested by the power-on self-test and includes further tests for gain, current source, and shunt circuitry.

When self-test is complete, either "Self-test Passed" or "Self-test Failed" appears on the screen. Execute the complete self-test before performing any verification or calibration procedures.

You must remove all input connections to the instrument before running the full self-test.

## Front Panel Execution

Press **[Shift] > [Utility] > Test/Admin > Self Test**.

## User Replaceable Parts

Replacement parts for the instrument are listed below. Unless otherwise shown, all parts apply to KM 3700.

| No. | Description |
|---|---|
| **1** | Bumper Part |
| **2** | Rear Bezel |
| **3** | Handle |
| **4** | Cover |
| **5** | Keypad |
| **6** | Display |
| **7** | Line Fuse (250mA, 250, time delay) |
| **8** | Current Protection Fuse (3.15A, 500V, time delay) |
| **9** | Internal Fuse (11A, 1000V, fast acting |
| **10** | Transformer |
| **11** | Terminal Latch |
| **12** | Power Module |
| **13** | Plastic Front Panel |
| **14** | Window |
| **15** | Fan |
| **16** | Cable Assembly, Thermistor |
| **17** | Battery (in front panel) |
| **18** | Reference Assembly |

# Disassembly

This section describes the procedure for disassembling the instrument.

**WARNING**

**Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover. Some circuits are active and have power applied even when the power switch is turned off.**

**Always disconnect all inputs, cords, and cables before disassembling the instrument.**

**CAUTION**

Do not turn the screw that fastens the shield in place, as this will affect the instrument's calibration.

## Tools Required

The following tools are required.

- Allen driver (most disassembly)
- Small, flat-blade screw driver (for prying)

## General Disassembly Procedure

1 Turn off the power and remove all measurement leads and other cables, including the power cord, from the instrument before continuing.

2 Rotate the handle to the upright position and remove it by pulling outward where it attaches to the case.



3 Remove eight captive screws on the front rubber bumper and pull off the rubber bumper.





4 Unscrew the four captive screws in the rear rubber bumper and remove the rubber bumper.



5 Remove the two captive screws on both front sides and place it in a safe location for re-assembly.



6 Unscrew the two captive screws on the top cover and slide off the top cover.



NOTE

*At this point, the instrument is sufficiently disassembled for power supply troubleshooting purposes. You could also change the battery or override calibration security at this point. If you need to disassemble the front panel, continue with the steps shown below.*

7 Use the small, flat-blade screwdriver to pry the black latch up and remove it. Note the orientation of the latch for re-assembly purposes.



8 Slide the front panel off.

9 Slide the black plastic lockers of the LCD cable connector and unplug the flat cable.



10 Remove the front panel PCBA by holding the connector housing shown below and lifting it out.



This concludes the disassembly procedure. To reassemble the instrument, reverse the procedure.

## Battery Replacement

This section describes the procedure for replacing the battery on the DMM's front panel.

**WARNING**

**Only qualified, service-trained personnel who are aware of the hazards involved should remove DMM covers. Always disconnect the power cable and any external circuits before removing the DMM cover. Some circuits are active and have power applied even when the power switch is turned off. Always disconnect all inputs, cords, and cables before disassembling the DMM.**

### Tools Required

- Allen driver (most disassembly)
- Small, flat-blade screw driver (for prying)

### Procedure

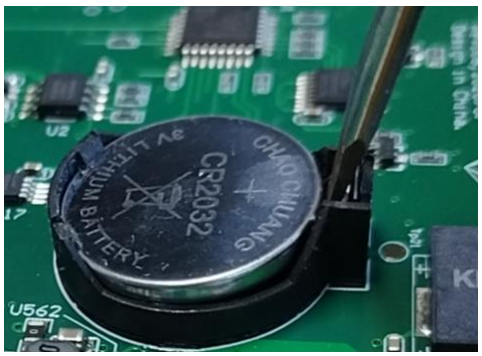
1 Turn off the power and remove all measurement leads and other cables, including the power cord, from the DMM before continuing.

2 Follow the disassembly procedure to disassemble the DMM.

3 Locate the battery on the front panel, and position the screwdriver tip under the battery, as shown.

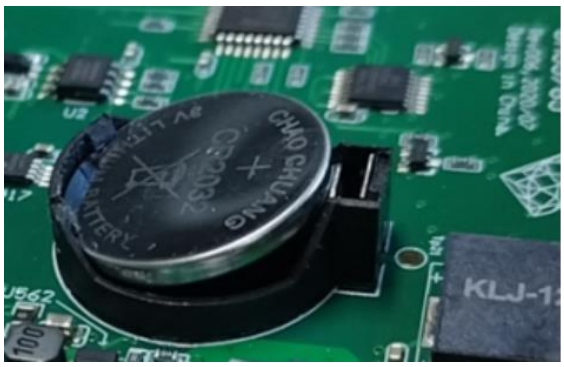



4 Use the screwdriver to pry the battery from the battery holder.




5 Remove the battery and discard or recycle it in accordance with all applicable regulations.

6 Position the new battery in the battery holder, + side up. Push down gently to seat the battery in the holder.



7 Reassemble the DMM completely before connecting any cables or cords. This concludes the battery replacement procedure.

# 3 A and 10 A Current Path Fuse Replacement

This section describes the procedure for testing and replacing the 3 A and 10 A current path fuses inside the DMM.

**WARNING**

**Only qualified, service-trained personnel who are aware of the hazards involved should remove DMM covers. Always disconnect the power cable and any external circuits before removing the DMM cover. Some circuits are active and have power applied even when the power switch is turned off.**

**Always disconnect all inputs, cords, and cables before disassembling the DMM.**

Do not turn the screw that fastens the shield in place, as this will affect the DMM's calibration.



## Tools Required

- Allen driver (most disassembly)
- Small, flat-blade screw driver (for prying)

## Testing the Fuses

### 3 A Current Path

To determine whether the instrument's 3 A current path has a fuse that must be replaced, press **[Cont]** to put the DMM in continuity measurement mode, and short the HI Input terminal to the 3 A current terminal. If the measurement displays OPEN, one of the two fuses must be replaced. One fuse is accessible from the instrument's rear panel; the other is internal.

If the 3 A current path has a bad fuse, it is very likely to be the fuse accessible from the lower left corner of the instrument's rear panel (3.15 A, 500 VAC/400 VDC, time delay).




Simply use a figure to push down and turn the fuse holder counterclockwise and access the fuse.



Put the new fuse into the fuse holder and insert the assembly back into the instrument, turning the fuse holder clockwise to lock it in place.

If the 3 A path still has a bad fuse, replace the internal 3 A current path fuse as described below.

**10 A Current Path**

To determine whether the instrument's 10 A current path has a fuse that must be replaced, press **[Cont]** to put the DMM in continuity measurement mode, and short the HI Input terminal to the 10 A current terminal. If the measurement displays OPEN, replace the internal 10 A current path fuse as described below.

## Internal Fuse Replacement Procedure

Both internal current path fuses are 11 A, 1000 V, fast acting. To replace an internal fuse:

1 Turn off the power and remove all measurement leads and other cables, including the power cord, from the instrument before continuing.

2 Follow the disassembly procedure to disassemble the instrument.

3 Locate the fuse to be replaced, as shown below.




4 Use the screwdriver to pry the fuse from the fuse holder, being careful not to damage the circuit board. For the 3 A fuse, it may be easiest to access the fuse from the side, through the rectangular aperture in the sheet metal.

5 Remove the fuse.

6 Position the new fuse in the fuse holder. Push down gently to seat the fuse in the holder.

7 Re-assemble the instrument completely before connecting any cables or cords.

This concludes with the fuse replacement procedure.

# Chapter 6 Calibration Procedure

You will need a test input cable and connectors set and a low thermal input short, Fluke 5720A, to calibrate the instrument

Perform the calibration procedures in the order listed in this document.

- ✧ Calibration Procedure
- ✧ Gain Calibration Adjustment Overview
- ✧ Gain and Flatness Calibration Adjustment Overview
- ✧ Self Test and Zero Calibration Procedure
- ✧ DC Voltage Gain Calibration
- ✧ DC Current Gain Calibration
- ✧ Ohms Gain Calibration
- ✧ AC Voltage Gain and Flatness Calibration
- ✧ AC Current Gain and Flatness Calibration
- ✧ Frequency Accuracy Calibration
- ✧ Capacitance Offset Calibration (Optional)
- ✧ Finishing Calibration

# Calibration Procedure

This section contains procedures for adjusting the instrument's performance.

NOTE

*There is no separate calibration for Diode or Continuity, because these functions are based on the resistance measurement, which is calibrated. Also, there is no calibration for gate time because this functionality is controlled by digital logic*.

### Closed-Case Electronic Calibration

The instrument uses closed-case electronic calibration; no internal mechanical adjustments are required.

The instrument calculates correction factors based on reference signals that you apply and stores the correction factors in non-volatile memory. This data is not changed by cycling power.

### Calibration Adjustment Interval

The instrument should be calibrated on a regular interval determined by the accuracy requirements of your application. A 1-year interval is adequate for most applications. Accuracy specifications are warranted only if calibration is made at regular calibration intervals. The manufacturer never recommends calibration adjustment intervals beyond two years.

### Calibration is Recommended

Whatever calibration interval you select, manufacturer recommends that complete re-

calibration should always be performed at the calibration interval. This ensures that the instrument will remain within specifications for the next calibration interval and provides the best long-term stability.

Use the calibration count to verify that all calibration adjustments have been performed.

### Time Required for Calibration Adjustment

The instrument can be automatically calibrated under computer control, including complete calibration adjustment procedure, in less than 30 minutes once the instrument is warmed-up (see Test Considerations).

## Input Connections

Test connections to the instrument are best accomplished using a high accuracy low-thermal 4-wire shorting plug for DMM to the calibrator output. Shielded, twisted-pair, PTFE interconnect cables of minimum length are recommended between the calibrator and the multimeter to reduce settling and noise errors. HI and HI Sense should be a twisted pair. LO and LO Sense should be a twisted pair.

Cable shields should be earth ground referenced. This configuration is recommended for noise reduction and settling time performance during calibration.

## Test Considerations

Errors may be induced by AC signals present on the input leads during a self–test. Long test leads can also act as an antenna causing pick–up of AC signals.
For optimum performance:

- Ensure that the calibration ambience temperature (Tcal) is stable and between 18 °C and 28 °C. Ideally the calibration should be performed at 23 °C ±2 °C.
- Ensure ambient relative humidity is less than 80%.
- Allow 90 minutes warm-up period with a copper short connected.
- Connect the input cable shields to earth ground. Except where noted in the procedures, connect the calibrator LO source to earth ground at the calibrator. It is important that the LO to earth ground connection be made at only one place in the circuit to avoid ground loops.

Because the instrument is capable of making highly accurate measurements, you must take care to ensure that the calibration standards and test procedures do not introduce additional errors. Ideally, the standards used to verify and adjust the instrument should be an order of magnitude more accurate than each instrument range full scale error specification.

For 2-wire ohms measurements, remove lead resistance by doing a null measurement with the leads shorted or with a precision 4-terminal low thermal short.
For offset calibration a 4-terminal low thermal short is required.

## Recommended Test Equipment

The recommended test equipment for the performance verification and calibration is listed below.

If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

| Application | Recommended Instrument |
|---|---|
| Zero Calibration | High accuracy low-thermal 4-wire shorting plug for DMM   |
| DC Voltage | Fluke5720A |
| DC Current | Fluke5720A |
| Resistance | Fluke5720A |
| AC Voltage | Fluke5720A |
| AC Current | Fluke5720A |
| Frequency | Fluke5720A |
| High Current | Fluke5720A |
| Capacitance (optional) | Fluke5720A |

## Gain Calibration Adjustment Overview

The ADC and zero calibration adjustment procedure must have been recently performed before beginning gain calibration. Gain calibrations can be made using either the front or rear input terminals. Make sure the **Front/Rear** switch matches the terminals in use.

NOTE

*Never turn off the instrument during a gain or flatness calibration. This may cause calibration memory for the present function to be lost.*

### Valid Gain and Flatness Calibration Input Values

Gain calibration can be accomplished using the following input values

| Function | Range | Valid Amplitude Input Values |
|---|---|---|
| DCV | 100 mV - 100 V | 0.9 - 1.1 × full scale |
| | 1000V | 900 V to 1050 V |
| DCI | 1μA - 10 μA | 0.5 - 1.5 × full scale |
| | 100 μA - 1 A | 0.9 - 1.1 × full scale |
| | 3 A | 2.7 A - 3.03 A |
| | 10 A | 9 A -11 A |
| ACI | 10 μA | 0.7 - 1.3 × full scale |
| | 100 μA - 1 A | 0.9 - 1.1 × full scale |
| | 3 A | 2.7 A - 3.03 A |
| | 10 A | 9 A - 11 A |
| ACV | 100 mV - 100 V | 0.9 - 1.1 × full scale |
| | 1000 V | 195 V - 770 V |
| Ω2W / Ω4W | 100 Ω - 10 MΩ | 0.9 - 1.1 × full scale |
| | 100 MΩ | Open circuit |
| CAP | 1 nF - 100 μF | 0.9 - 1.1 × full scale |
| FREQ | 10 V | 2Vrms - 11Vrms / 9.5 kHz – 25 kHz |

# Gain and Flatness Calibration Adjustment Overview

The instrument stores new flatness correction constants each time this procedure is followed. Flatness constants adjust the DMM for AC Volts and AC current measurements across the usable input frequency band. The flatness constant is computed from the calibration value entered for the calibration command and from measurements made automatically during the calibration procedure.

Calibrations for each range and frequency should be performed in the order shown.

### Flatness Calibration Considerations

The ADC and zero calibration adjustment procedure must have been recently performed before beginning gain calibration. Flatness calibrations can be made using either the front or the rear input terminals. Make sure the **Front/Rear** switch matches the terminals in use.

**CAUTION**

Never turn off the instrument during a gain or flatness calibration. This may cause calibration memory for the present function to be lost.

### Gain Calibration

The instrument calculates and stores gain corrections for each input value. The gain constant is computed from the calibration value entered for the calibration command and from measurements made automatically during the calibration procedure.

Most measurement functions and ranges have gain calibration procedures, and calibration for each function should be performed in the order shown.

# Self Test and Zero Calibration

Each time you perform a zero calibration, the instrument stores a new set of offset correction constants for every measurement function and range. The instrument automatically sequences through all required functions and ranges and stores new zero offset calibration constants.

All offset corrections are determined automatically.

**CAUTION**

Never turn off the instrument during Zero Calibration. This may cause ALL calibration memory to be lost.

## Self Test and DC Zero Calibration Procedure

This calibration procedure applies to all models.

Be sure to allow the instrument to warm up and stabilize for 90 minutes before performing the calibration.

1 Follow the steps outlined below. Review Test Considerations before beginning this test.

2 Select the **Self Test ( [Shift] + [Display] > [Utility] Test/Admin > Self Test).**

**NOTE**

*Disconnect all input signals before proceed the **Self Test**.*

3 The display will show a message indicating that Self-test calibration is in progress.

It will then display the results of the Self Test calibration.

A passed message for a self-test indicates success; if the display shows that the self-test failed, check the input value, range, and function, enter the calibration value, and repeat the self-test step.

4 This procedure uses a low-thermal shorting block installed on the input connectors.

For the KM 3700, two shorting blocks are recommended: one on the front panel and one on the rear panel. Short-circuit is suitable for DCV, DCI, RES, FRES, ACV, ACI zero calibration.



5 Select the front panel input terminals. Install a shorting block on the front panel input terminals.

6 Select the DCV measurement function. Set Range=100mV, Sign=Pos, Value= 0.

7 Press **Start**.

8 The Zero Calibration lasts approximately two minutes. A Calibration Step Succeeded message indicates success; if the display shows Calibration Step Failed, check the input value, range, function, and entered calibration value and repeat the calibration step.

9 Select the rear input terminals. Install a shorting block rear panel input terminals.

10 Repeat steps 6 through 8 for the rear input terminals.

11 Switch **DCI, RES, and FREQ** to complete DC zero calibration.

NOTE

*Zero calibration for all ranges under the same function is completed at one time, so there's no need to repeat the calibration for each range.*

## DC Voltage Gain Calibration

Configuration: DC Voltage

1 Configure each function and range in the order shown in the table below.

2 Apply the input signal shown in the Input column.

3 **Enter the actual applied input voltage amplitude**. A Calibration Step Succeeded message indicates success; if the display shows Calibration Step Failed, check the input value, range, function, and entered calibration value and repeat the calibration step.

4 Repeat steps 1 through 3 for each gain calibration point shown in the table.

| Input | Instrument Settings | |
|---|---|---|
| | Function | Range |
| 10 V | DC Voltage | 10 V |
| -10 V | | |
| 100 mV | | 100 mV |
| -100 mV | | |
| 1 V | | 1 V |
| -1 V | | |
| 100 V | | 100 V |
| -100 V | | |
| 1000 V | | 1000 V |
| -1000 V | | |

## DC Current Gain Calibration

Configuration: DC Current

1 Configure each function and range in the order shown in the table below.

2 Apply the input signal shown in the Input column.

3 Enter the actual applied input current as the Cal Value. A Calibration Step Succeeded message indicates success; if the display shows Calibration Step Failed, check the input value, range, function, and entered calibration value and repeat the calibration step.

4 Repeat steps 1 through 3 for each gain calibration point shown in the table.

| Input | Instrument Settings | |
|---|---|---|
| | Function | Range |
| 1 µA | DC Current | 1 µA |
| -1 µA | | |
| 10 µA | | 10 µA |
| -10 µA | | |
| 100 µA | | 100 µA |
| -100 µA | | |
| 1 mA | | 1 mA |
| -1 mA | | |
| 10 mA | | 10 mA |
| -10 mA | | |
| 100 mA | | 100 mA |
| -100 mA | | |
| 1 A | | 1 A |
| -1 A | | |
| 3 A | | 3 A |
| -3 A | | |
| 10 A | | 10 A |
| -10 A | | |

## Ohms Gain Calibration

This calibration procedure applies to all models.

Review Test Considerations and Gain Calibration Considerations before beginning this procedure.

Configuration: 4-Wire Ohms

This procedure adjusts the gain for the 2-wire and 4-wire Ohms functions, and the offset compensated Ohms function.

1 Configure each function and range in the order shown in the table below.

2 Apply the input signal shown in the Input column.

3 Enter the actual applied input resistance (see Entering Calibration Values). A Calibration Step Succeeded message indicates success; if the display shows Calibration Step Failed, check the input value, range, function, and entered calibration value and repeat the calibration step.

4 Repeat steps 1 through 3 for each gain calibration point shown in the table.

| Input | Instrument Settings | |
|---|---|---|
| | Function | Range |
| 100 Ω | 4- wire Ohms | 100 Ω |
| 1 kΩ | | 1 kΩ |
| 10 kΩ | | 10 kΩ |
| 100 kΩ | | 100 kΩ |
| 1 MΩ | | 1 MΩ |
| 10 MΩ | | 10 MΩ |
| 100 MΩ | 2- wire Ohms<br>Input HI short circuit Sense HI.<br>Input LO short circuit Sense LO. | 100 MΩ |

## AC Voltage Gain and Flatness Calibration

Review Test Considerations and Flatness Calibration Considerations before performing any calibration.

Configuration: AC Voltage

All AC calibration procedures use the 3 Hz bandwidth measurement filter.

1 Configure each function and range in the order shown in the table below.

2 Apply the input signal shown in the Input column.

3 **Enter the actual applied input voltage amplitude** (see Entering Calibration Values). A Calibration Step Succeeded message indicates success; if the display shows Calibration Step Failed, check the input value, range, function, and entered calibration value and repeat the calibration step.

4 Repeat steps 1 through 3 for each flatness calibration point shown in the table.

| Input | | Instrument |
|---|---|---|
| **Vrms** | **Frequency** | **Range** |
| 1 mV | 1 kHz | 100 mV |
| 50 mV | 1 kHz | |
| 100 mV | 1 kHz, 20 kHz, 50 kHz, 100 kHz, 150 kHz, 300 kHz | |
| 0.5 V | 1 kHz | 1 V |
| 1 V | 1 kHz, 20 kHz, 50 kHz, 100 kHz, 150 kHz, 300 kHz | |
| 5 V | 1 kHz | 10 V |
| 10 V | 1 kHz, 10 kHz, 20 kHz, 50 kHz, 100 kHz, 150 kHz, 300 kHz | |
| 50 V | 1 kHz | 100 V |
| 100 V | 1 kHz, 20 kHz, 50 kHz, 100 kHz, 150 kHz, 300 kHz | |
| 375 V | 1 kHz | 750 V |
| 750 V | 1 kHz, 20 kHz, 50 kHz, 100 kHz, 150 kHz, 300 kHz | |

NOTE

*Gain and flatness calibration can be done with front and rear terminals. Make sure the Front/Rear switch matches the terminal being used.*

## AC Current Gain and Flatness Calibration

Review Test Considerations and Flatness Calibration Considerations before performing any calibration.

Configuration: AC Current

All AC calibration procedures use the 3 Hz bandwidth measurement filter.

1 Select each range in the order shown in the table below.

2 Apply each input current and frequency shown in the Input columns.

3 Enter the actual applied input current as the Cal Value (see Entering Calibration Values). A Calibration Step Succeeded message indicates success; if the display shows Calibration Step Failed, check the input value, range, function, and entered calibration value and repeat the calibration step.

4 Repeat steps 1 through 3 for each frequency shown in the table.

5 Repeat steps 1 through 4 for each current range in the table.

| Input | | Instrument |
|---|---|---|
| **Current** | **Frequency** | **Range** |
| 10 µA | 1 kHz, 2 kHz, 3 kHz, 4 kHz, 5 kHz, 6 kHz, 7 kHz, 8 kHz, 9 kHz, 10 kHz | 10 µA |
| 50 µA | 1 kHz | 100 µA |
| 100 µA | 1 kHz, 5 kHz, 10 kHz | |
| 0.5 mA | 1 kHz | 1mA |
| 1 mA | 1 kHz, 5 kHz, 10 kHz | |
| 5 mA | 1 kHz | 10 mA |
| 10 mA | 1 kHz, 5 kHz, 10 kHz | |
| 50 mA | 1 kHz, 5 kHz | 100 mA |
| 100 mA | 10 Hz, 1 kHz, 10 kHz | |
| 0.5 A | 1 kHz | 1 A |
| 1 A | 1 kHz, 5 kHz, 10 kHz | |
| 1.5 A | 1 kHz | 3 A |
| 3 A | 1 kHz, 5 kHz, 10 kHz | |
| 5 A | 1 kHz | 10 A |
| 10 A | 1 kHz, 5 kHz, 10 kHz | |

## Frequency Accuracy Calibration

Review Test Considerations and Gain Calibration Considerations before beginning this procedure.

Configuration: Frequency, 10 V range

1 Configure the instrument for frequency measurements at 10 V and 10 kHz, with 1 second gate time.

2 Apply a 10kHz sine wave, amplitude between 9 and 11 Vrms.

3 Enter the actual applied input frequency (see Entering Calibration Values). A Calibration Step Succeeded message indicates success; if the display shows Calibration Step Failed, check the input value, range, function, and entered calibration value and repeat the calibration step.

## Capacitance Offset Calibration (Optional)

This calibration is normally not required. It compensates for residual capacitance offset which is typically less than a few pF. In normal use, any residual offset will be overridden by the null function (null also corrects for cable capacitance), and the null function is required to achieve the multimeter's capacitance specification.

Configuration: Capacitance

1 Remove all connections from the instrument's front terminals.

2 Select the front terminals.

3 Enter a calibration value of +0 (see Entering Calibration Values). A Calibration Step Succeeded message indicates success; if the display shows Calibration Step Failed, check the input value, range, function, and entered calibration value and repeat the calibration step.

4 Repeat steps 1 through 3 for the instrument's rear terminals.

5 Select each range in the order shown in the table below.

6 Provide the indicated input.

7 Compare measurement results (Be certain to allow time for source settling.)

| Input | |
|---|---|
| **Capacitance** | **Range** |
| 1 nF | 1 nF |
| 10 nF | 10 nF |
| 100 nF | 100 nF |
| 1 µF | 1 µF |
| 10 µF | 10 µF |
| 100 µF | 100 µF |

## Finishing Calibration

To finish calibrating your instrument:

1 Remove all shorting blocks and connections from the instrument.

2 Reset the calibration message.

3 Record the new calibration count.

# Chapter 7 Remote Control

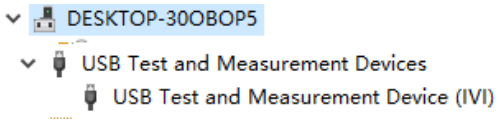
The instrument supports remote interface communication over three interfaces: USB, and LAN. All three are "live" at power up when the instrument ships from the factory.

- ✧ USB Communication
- ✧ LAN Communication

# USB Communication

USB Interface: Use the rear-panel USB connector to communicate with your PC.

Connect the DMM to a computer via USB cable. A new device will be displayed in the computer Device Manager.



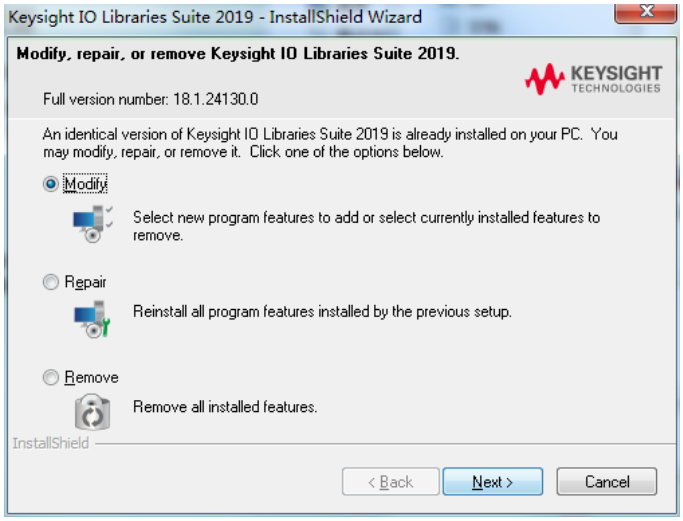

## Install the IO driver

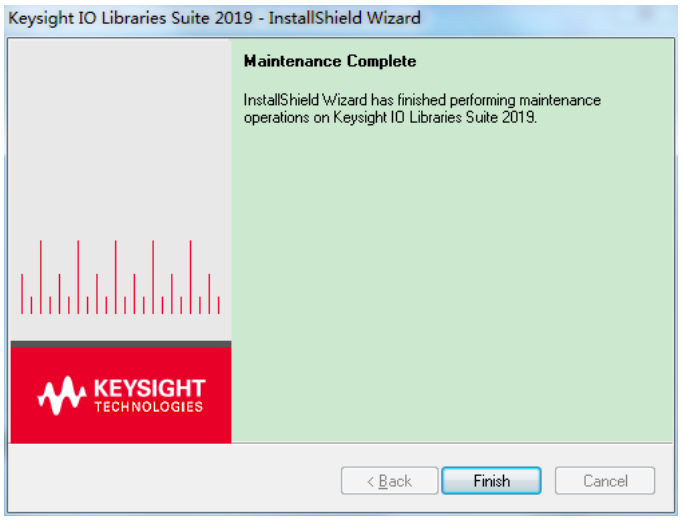
You need to first install the IO driver on your computer.

Click the following URL to download the latest version of IO driver package:

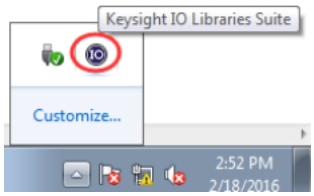
https//www.keysight.com/main/software.jspx?ckey=2175637&lc=chi&cc=CN&nid=-11143.0.00&id=2175637

Double-click on IOLibSuite_18_1_24130 file to run the installer. Follow the instructions on the screen to install the driver.



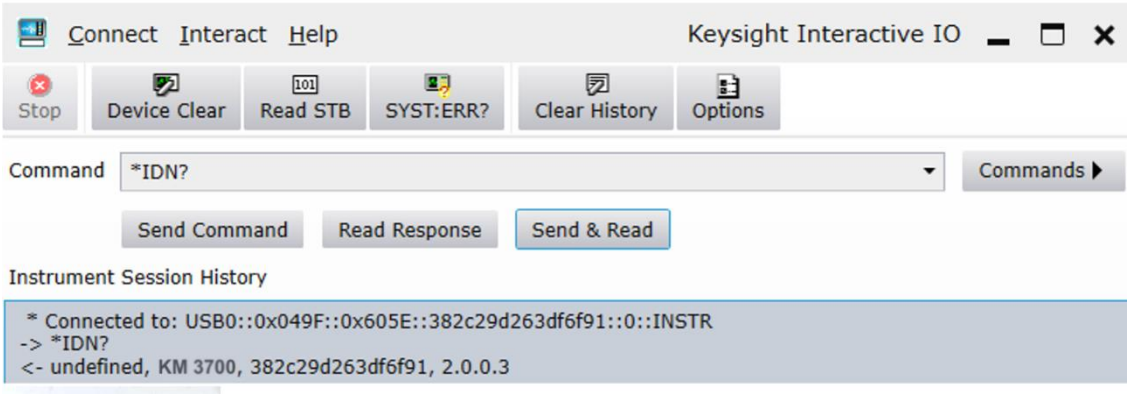
After installing IO software, you can see the IO icon in the taskbar notification area on your computer, typically located in the lower right corner of the screen.




Double-click to run the IO software. In My Instrument -> USB you can view the connected device information.

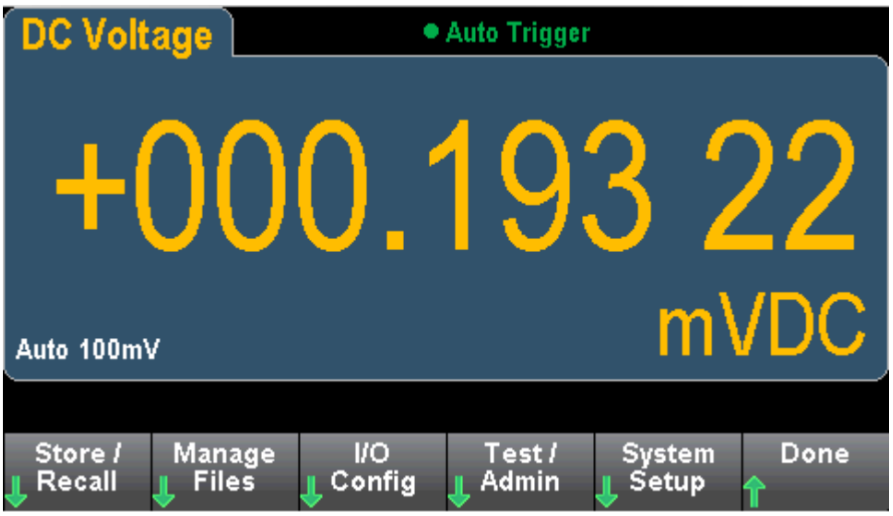



Click on the "Interactive IO", a command is sent arbitrarily, and the computer communicates with the device (DMM).



## LAN Communication

Connect one end of the LAN cable to the computer and the other end to the LAN terminal on the multimeter's rear panel. Press the composite keys [Shift] + [Display] on the front panel of KM 3700 to enter the I/O Config interface in the Utility menu.




LAN Settings.

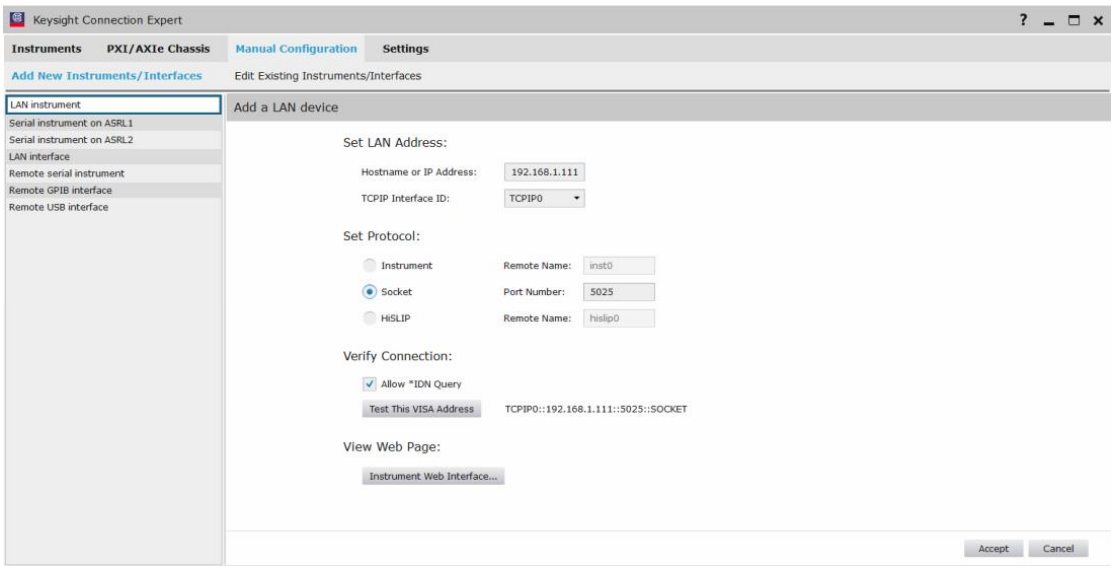
Set IP Mode to Static, set IP Addr and Gateway manually, and then click Apply. When the message "Set IP address successfully" is displayed, it signifies that the IP address has been configured correctly.




Manually adjust the IP address of your computer to be on the same network segment as the DMM.

Configure IO Libraries Suite:

- **Open IO Libraries Suite:** Launch the software on your computer.
- **Select LAN instrument:** In the IO Libraries configuration, choose "LAN instrument".
- **Manual Configuration:** Select "Manual Configuration".
- **Enter the KM 3700's IP address:** In the "Hostname or IP Address" field, enter the IP address of the KM 3700.
- **Set the protocol:** Select "Socket" as the protocol and set the "Port Number" to 5025.
- **Save the configuration:** Follow the prompts to save the new instrument configuration.




Click Test This VISA Address to verify the connection.




If the connection test is successful, click Accept to add the instrument.

When the IP Mode is set to DHCP in LAN Settings, the router automatically assigns IP addresses and other network configuration details (like the gateway) to DMM on the network. Therefore, manual configuration of the IP address and gateway is not necessary.

If the assignment is successful, the message "Set IP address successfully" is displayed; if failed, “Map IP address failed!” is shown.

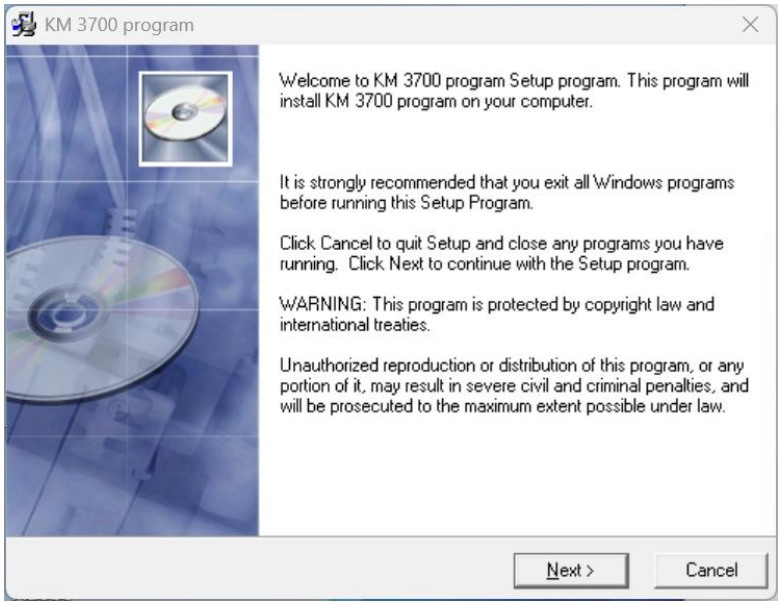
If the DHCP assignment fails, the original IP address of the DMM is not changed. After the DHCP IP address is successfully assigned, the communication between DMM and computer is as the IP Mode Static.

## Install the software

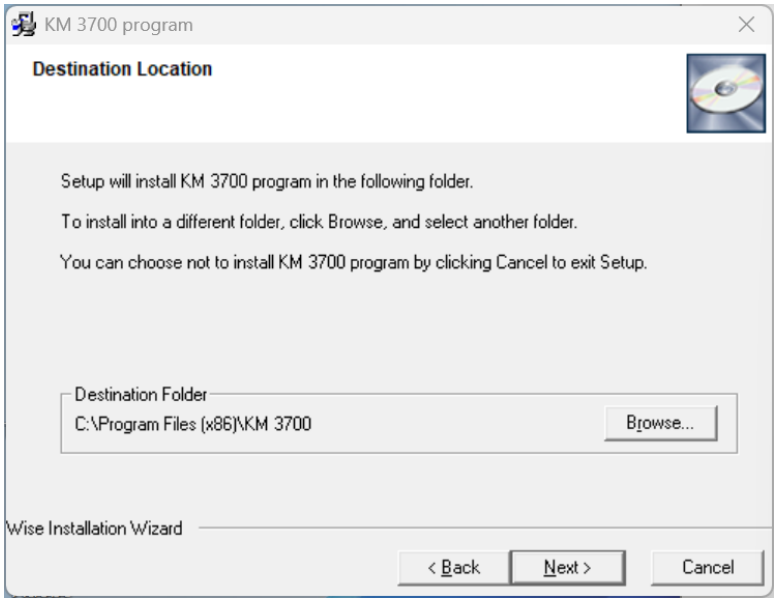
Double-click on “KM 3700.exe” to install the DMM software.



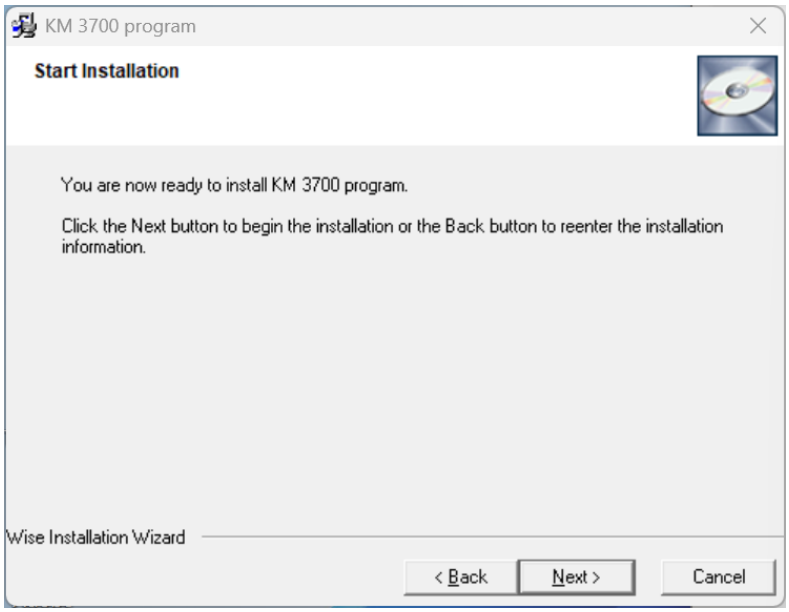

Select “Next” to start the installation.



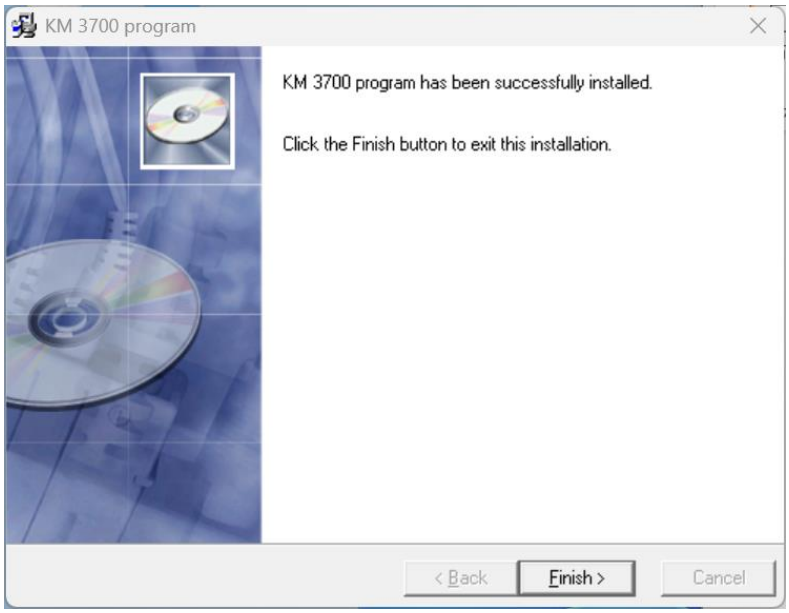

Select the location on the computer you want to install the software.



Follow the installation instructions and select “Next” to start the installation.




Click “Finish” to complete the software installation.




Double-click the DMM software icon as follows




to display KM 3700 interface.


KM 3700
DC Voltage
Auto Trigger
21.564060
Auto 100mV
uVDC
Range
Auto
Aperture
10 PLC
Auto Zero
Off On
Input
10M Auto
DCV Ratio
Off On
DCI
DCV
ACI
ACV
Ω4W
Ω2W
Freq
Cont
Temp
Save
Run/Stop
Probe Hold
Single
Math
Null
Utility
Display
Acquire
Shift
Local
Range
OK
Sense
Ω4W
Input
V Ω
HI
LO
200Vpk
1000VDC
750VAC
500Vpk
10A
3A
Front
Rear
CAT II (300V)

# Chapter 8 Specification

The specifications apply when the instrument is warmed up for at least 30 minutes and operates in slow rate.

Below are the basic conditions required to operate the DMM within specifications:

• Calibration: Yearly
• Operating Temperature Specification: 18 to 28˚C (64.4 to 82.4˚F)
• Relative Humidity: 80% (Noncondensing)
• Accuracy: ± (% of Reading + Digits)
• AC measurements are based on a 50% duty cycle.
• The power supply cable must be grounded to ensure accuracy.
• All specifications are applicable to the primary display only.

# Specification

Accuracy specifications: ± (% reading + % range)[1]

| Range[2]/Frequency | 24 hours[3] $T_{CAL}$ ± 1 °C | 90 days $T_{CAL}$ ± 5 °C | 1 year $T_{CAL}$ ± 5 °C | 2 years $T_{CAL}$ ± 5 °C | Temperature Coefficient/°C[4] |
|---|---|---|---|---|---|
| **DC voltage** | | | | | |
| 100 mV | 0.0030 + 0.0030 | 0.0040 + 0.0035 | 0.0040 + 0.0035 | 0.0045 + 0.0035 | 0.0005 + 0.0005 |
| 1 V | 0.0010 + 0.0004 | 0.0015 + 0.0004 | 0.0020 + 0.0004 | 0.0025 + 0.0004 | 0.0005 + 0.0001 |
| 10 V | 0.0008 + 0.0002 | 0.0013 + 0.0002 | 0.0016 + 0.0002 | 0.0020 + 0.0002 | 0.0005 + 0.0001 |
| 100 V | 0.0020 + 0.0006 | 0.0032 + 0.0006 | 0.0038 + 0.0006 | 0.0040 + 0.0006 | 0.0005 + 0.0001 |
| 1000 V[5] | 0.0020 + 0.0006 | 0.0032 + 0.0006 | 0.0038 + 0.0006 | 0.0040 + 0.0006 | 0.0005 + 0.0001 |
| **Resistance[6] (Test Current)** | | | | | |
| 100 Ω | 0.0030 + 0.0030 | 0.008 + 0.004 | 0.010 + 0.004 | 0.012 + 0.004 | 0.0006 + 0.0005 |
| 1k Ω | 0.0020 + 0.0005 | 0.008 + 0.001 | 0.010 + 0.001 | 0.012 + 0.001 | 0.0006 + 0.0001 |
| 10 kΩ | 0.0020 + 0.0005 | 0.008 + 0.001 | 0.010 + 0.001 | 0.012 + 0.001 | 0.0006 + 0.0001 |
| 100 kΩ | 0.0020 + 0.0005 | 0.008 + 0.001 | 0.010 + 0.001 | 0.012 + 0.001 | 0.0006 + 0.0001 |
| 1 MΩ | 0.002 + 0.001 | 0.008 + 0.001 | 0.010 + 0.001 | 0.012 + 0.001 | 0.0010 + 0.0002 |
| 10 MΩ | 0.015 + 0.001 | 0.020 + 0.001 | 0.040 + 0.001 | 0.060 + 0.001 | 0.0030 + 0.0004 |
| 100 MΩ | 0.300 + 0.010 | 0.800 + 0.010 | 0.800 + 0.010 | 0.800 + 0.010 | 0.1500 + 0.0002 |
| **DC Current** | | | | | |
| 1 µA[7] (typ) | 0.700 + 0.010 | 3.000 + 0.010 | 5.000 + 0.010 | 6.000 + 0.010 | 0.2000 + 0.0020 |
| 1 µA[8] (typ) | 0.070 + 0.005 | 0.300 + 0.005 | 0.500 + 0.005 | 0.600 + 0.005 | 0.0020 + 0.0010 |
| 10 µA (typ) | 0.007 + 0.002 | 0.030 + 0.002 | 0.050 + 0.002 | 0.060 + 0.002 | 0.0015 + 0.0006 |
| 100 µA (typ) | 0.007 + 0.001 | 0.030 + 0.001 | 0.050 + 0.001 | 0.060 + 0.001 | 0.0015 + 0.0004 |
| 1 mA | 0.007 + 0.003 | 0.030 + 0.005 | 0.050 + 0.005 | 0.060 + 0.005 | 0.0015 + 0.0005 |
| 10 mA | 0.007 + 0.020 | 0.030 + 0.020 | 0.050 + 0.002 | 0.060 + 0.002 | 0.0020 + 0.0020 |
| 100 mA | 0.010 + 0.004 | 0.030 + 0.005 | 0.050 + 0.005 | 0.060 + 0.005 | 0.0020 + 0.0005 |
| 1 A | 0.050 + 0.006 | 0.070 + 0.010 | 0.080 + 0.010 | 0.100 + 0.010 | 0.0050 + 0.0010 |
| 3 A | 0.180 + 0.020 | 0.200 + 0.020 | 0.200 + 0.020 | 0.230 + 0.020 | 0.0050 + 0.0020 |
| 10 A[9] | 0.050 + 0.010 | 0.120 + 0.010 | 0.120 + 0.010 | 0.150 + 0.010 | 0.0050 + 0.0010 |

| | | | | | |
|---|---|---|---|---|---|
| **Continuity** | | | | | |
| 1 kΩ | 0.002 + 0.030 | 0.008 + 0.030 | 0.010 + 0.030 | 0.012+ 0.030 | 0.0010 + 0.0020 |
| **Diode test[10]** | | | | | |
| 5 V | 0.002 + 0.030 | 0.008 + 0.030 | 0.010 + 0.030 | 0.012+ 0.030 | 0.0010 + 0.0020 |
| **True RMS AC voltage [11,12]** | | | | | |
| **Range: 100 mV 1 V, 10 V, 100 V and 750 V** | | | | | |
| 3 Hz-5 Hz | 0.50 + 0.02 | 0.50 + 0.02 | 0.50 + 0.02 | 0.50 + 0.02 | 0.010 + 0.003 |
| 5 Hz-10 Hz | 0.10 + 0.02 | 0.10 + 0.02 | 0.10 + 0.02 | 0.11 + 0.02 | 0.008 + 0.003 |
| 10 Hz-20 kHz | 0.02 + 0.02 | 0.04 + 0.02 | 0.05 + 0.02 | 0.06 + 0.02 | 0.007 + 0.003 |
| 20 kHz-50 kHz[7] | 0.05 + 0.03 | 0.06 + 0.03 | 0.07 + 0.03 | 0.08 + 0.03 | 0.010 + 0.005 |
| 50 kHz-100 kHz | 0.15 + 0.05 | 0.15 + 0.05 | 0.15 + 0.05 | 0.15 + 0.05 | 0.060 + 0.008 |
| 100 kHz-300 kHz | 1.00 + 0.10 | 1.00 + 0.10 | 1.00 + 0.10 | 1.00 + 0.10 | 0.200 + 0.020 |
| **True RMS AC current[13,14]** | | | | | |
| **Range: 10 µA** | | | | | |
| 3 Hz-5 kHz | | 0.35 + 0.04 | 0.40 + 0.04 | 0.40 + 0.04 | 0.055 + 0.006 |
| 5 kHz-10 kHz (typ) | | 0.35 + 0.04 | 0.40 + 0.04 | 0.40 + 0.04 | 0.055 + 0.006 |
| **Range: 100 µA, 1 mA, 10 mA, 100 mA, 1A** | | | | | |
| 3 Hz-5 kHz | 0.07 + 0.04 | 0.09 + 0.04 | 0.10 + 0.04 | 0.10 + 0.04 | 0.015 + 0.006 |
| 5 kHz-10 kHz (typ) | 0.10 + 0.04 | 0.10 + 0.04 | 0.10 + 0.04 | 0.10 + 0.04 | 0.030 + 0.006 |
| **Range: 3A** | | | | | |
| 3 Hz-5 kHz | 0.23 + 0.04 | 0.23 + 0.04 | 0.23 + 0.04 | 0.23 + 0.04 | 0.015 + 0.006 |
| 5 kHz-10 kHz (typ) | 0.23 + 0.04 | 0.23 + 0.04 | 0.23 + 0.04 | 0.23 + 0.04 | 0.030 + 0.006 |
| **Range: 10 A** | | | | | |
| 3 Hz-5 kHz | 0.10 + 0.04 | 0.15 + 0.04 | 0.15 + 0.04 | 0.15 + 0.04 | 0.015 + 0.006 |
| 5 kHz-10 kHz (typ) | 0.15 + 0.04 | 0.15 + 0.04 | 0.15 + 0.04 | 0.15 + 0.04 | 0.030 + 0.006 |
| **Frequency[15,16]** | | | | | |
| **Range: 100 mV, 1 V, 10 V, 100 V and 750 V[17]** | | | | | |
| 3 Hz-40 Hz | 0.070 | 0.070 | 0.070 | 0.070 | 0.035 |
| 40 Hz-100 Hz | 0.030 | 0.030 | 0.030 | 0.030 | 0.035 |
| 100 Hz-1 kHz | 0.003 | 0.006 | 0.007 | 0.010 | 0.015 |
| 1 kHz-300 kHz | 0.002 | 0.005 | 0.007 | 0.009 | 0.015 |
| Square Wave[15] | 0.001 | 0.004 | 0.006 | 0.008 | 0.015 |

**Additional frequency errors ± (% of reading)[15]**

| Aperture (resolution/range) | 1 second (0.1 ppm) | 0.1 second (1 ppm) | 0.01 second (10 ppm) |
|---|---|---|---|
| 3 Hz-40 Hz | 0 | 0.200 | 0.200 |
| 40 Hz-100 Hz | 0 | 0.060 | 0.200 |
| 100 Hz-1 kHz | 0 | 0.020 | 0.200 |
| 1 kHz-300 kHz | 0 | 0.004 | 0.030 |
| Square Wave[15] | 0 | 0.000 | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| **Capacitance[16]** | | | | | |
| 1.000 nF | 0.50 + 0.50 | 0.50 + 0.50 | 0.50 + 0.50 | 0.50 + 0.50 | 0.05 + 0.05 |
| 10.00 nF | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.05 + 0.01 |
| 100.0 nF | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.05 + 0.01 |
| 1.000 µF | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.05 + 0.01 |
| 10.000 µF | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.05 + 0.01 |
| 100.00 µF | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.40 + 0.10 | 0.05 + 0.01 |

| Temperature | |
|---|---|
| PT100 (DIN/ IEC 751) [18] | Probe accuracy + 0.05 °C |
| 5 kΩ Thermistor | Probe accuracy + 0.10 °C |
| **DC current burden voltage at full scale** | |
| **DC current range** | **Burden voltage** |
| 1 µA | < 0.11 V |
| 10 µA | < 0.11 V |
| 100 µA | < 0.11 V |
| 1 mA | < 0.11 V |
| 10 mA | < 0.11 V |
| 100 mA | < 0.11 V |
| 1 A | < 0.11 V |
| 3 A | < 0.33 V |
| 10 A | < 0.11 V |

1. These specifications are valid in the following conditions: warm up for 90 minutes, aperture of 10 or 100NPLC, and auto zero on, slow AC filter.
2. Except 1,000 DCV, 750 ACV, 3A/10A Current, and diode test have 0%, 20% overrange on all ranges.
3. In relation to the calibration standards.
4. Add this for each degree (°C) outside $T_{CAL}$ ± 5 °C.
5. For each additional volt exceeds ± 500 V add 0.02 mV of error.
6. Specifications are for 4-wire ohms function or 2-wire ohms using math null for offset. Without math null, add 0.2Ω additional error in 2-wire ohms function.
7. Specifications are for DCI input ≥ 0 and ≤+20% of range, and ≤ 0 and ≥ -20% of range.
8. Specifications are for DCI input in the range other than “7” stated.
9. The 10 A range is only available from a separate connector on the front panel.
10. Specifications are for the voltage measured at the input terminals. The 1 mA test current is typical. Variation in the current source will create some variation in the voltage drop across a diode junction.
11. Specifications are for:
When sine wave frequency ≤ 100KHz, and range from 100 mV to 100 V, sine wave input > 0.3% of range and > 1 mVrms. If in 750V range, specifications are for sine wave input amplitude > 5% of range.
When sine wave frequency > 100KHz and ≤ 300KHz, sine wave input > 0.8% of range and > 1 mVrms. For each additional volt over 300 Vrms add 1 mVrms of error.
12. Low-frequency performance: three filter settings are available: 3 Hz, 20 Hz, 200 Hz. Frequencies greater than these filter settings are specified with no additional errors.
13. Specifications are for sine wave input > 1% of range and > 9 µArms.
14. Unless stated otherwise, specifications are for sine wave input.
15. Square wave input specified for 10 Hz to 300 kHz for 1 second aperture. For shorter apertures, the minimum frequency requires > 2 cycles.
16. Specifications are for using Math Null zeroing. High dissipation factor capacitors may show different results than a single frequency measurement. Film capacitors usually have lower dissipation factors than other dielectrics.
17. Input > 100 mV. For 10 mV to 100 mV inputs, multiply % of reading error x10. Amplitude 10% to 120% of range except 14% to 100% for the 750 ACV range. Specifications are for 1-second gate time (7 digits).
18. Actual measurement range and probe errors will be limited by the selected probe. Probe accuracy adder includes all measurement and ITS-90 temperature conversion errors. PT100 Ro settable to 100Ω ± 5Ω to remove the initial probe error.

KUSAM-MECO®

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