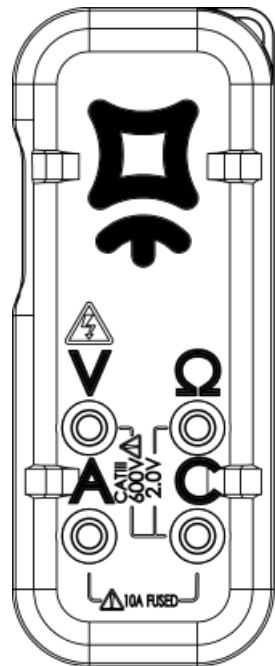

MOOSHIMETER USER'S MANUAL



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INTRODUCTION

The Mooshim Mooshimeter BLE-DMM-2X-01A (hereafter “The Meter”) is a battery powered multimeter capable of handheld and remote usage via Bluetooth Low Energy. This manual details how to safely use your Mooshimeter.

The Meter meets CAT III IEC 61010-1 3rd edition and 61010-2-030 standards. Overvoltage category III (CAT III) defines a level of safety appropriate for the transient overvoltages present in fixed equipment installations at the distribution level. This includes the mains installation of a building, distribution boards, busbars, and permanently connected equipment. Do not use this multimeter for CAT IV circuits, which includes any mains circuits not protected by a building’s breakers.

PACKAGE CONTENTS

- Mooshimeter (1)
 - 1.5V AA Alkaline Batteries installed (2)
 - 12A HRC fuse installed (1)
- Spare Fuse (1)
- Test Leads (3)
- Alligator Clip Attachment (3)
- Carrying case (1)

SAFETY INFORMATION

WARNING Denotes a potentially hazardous situation that may result in injury or death

CAUTION Denotes a potentially hazardous situation that may result in damage to the meter

NOTE Denotes a situation that may result in degraded or incorrect measurement

- Use caution in the operation of this device. Improper use may result in injury or death. Read this user manual before operating the meter.
- Always remove leads before opening the case.
- Do not operate the meter unless it is fully assembled with both case screws tight.
- Only use appropriately rated fuses.
- Always check for damage before use. Pay special attention to the test leads for signs of damaged insulation or exposed conductors. Immediately replace damaged leads.
- Only use test leads that are rated to at least CAT III 600V.
- Keep fingers behind the guards on the leads.
- Use caution working with voltages above 30VAC rms, 42VAC peak, or 60VDC. Voltages this high pose risk of shock.
- Never apply more than 600V between any terminal and earth ground.
- Do not apply more than 2.0V to the Ω terminal with respect to C . Doing so may draw unexpected current and trigger protection circuits. In this event, basic functionality will automatically return within one minute. Accuracy may be adversely affected for up to five minutes.
- Error messages may appear on the user interface. Read these messages for further information.

TABLE 1 SYMBOLS

| | |
|--|---|
| | Caution: Risk of Electric Shock. Refer to operating instructions. |
| | Important Information: Refer to operating instructions. |
| | This instrument is rated for installation category III per IEC 61010. |
| | Double Insulation |
| | Terminal protected by fuse. Current limit of 10A RMS. |
| | Conforms to European Union Directives |
| | Do not exceed 600V with respect to ground. |

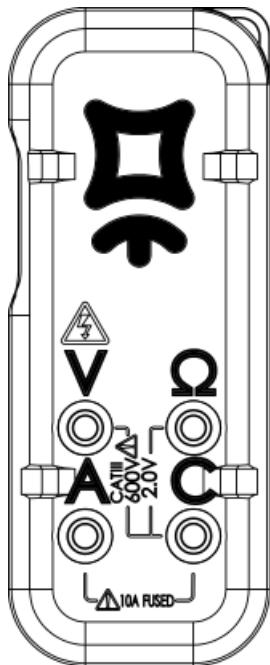


TABLE 2 TERMINALS

| Terminal | Description |
|----------|--|
| C | Common terminal for all measurements |
| A | Input terminal for measuring currents to 10A RMS (AC and DC) |
| V | Input terminal for measuring voltages to 600V RMS (AC and DC) |
| Ω | Input terminal for measuring resistance, diode drop, and voltages up to 1.2V |

BASIC MEASUREMENT INSTRUCTIONS

MEASURING VOLTAGE

WARNING *Risk of Electrocution. For determining whether a circuit is "live" exercise caution if the meter does not report a voltage. This may indicate a poor connection to the circuit being tested. Make sure the probe tips are fully in contact with the circuit before assuming the circuit is safe.*

Two of the Mooshimeter's input terminals are capable of making basic voltage measurements:

The **V** terminal can measure up to 600V RMS and is intended for traditional AC and DC voltage measurements.

The **Ω** terminal can measure up to 1V peak (~0.7V RMS for pure-sine AC) and allows for several new measurement techniques described later in this manual.

See the ratings section for further details on the measurement ranges.

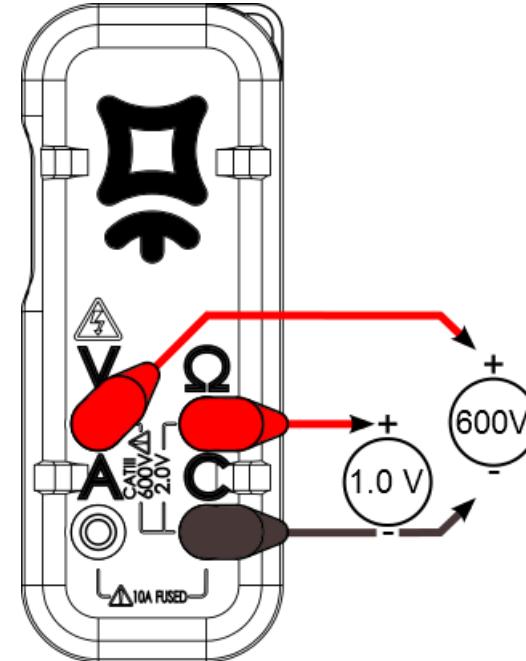


FIGURE 1 BASIC VOLTAGE MEASUREMENT

MEASURING CURRENT WITH INTERNAL CURRENT SHUNT

WARNING *Exercise care when connecting in series with a circuit, especially those containing motors or other large inductances. Sudden disconnects may create higher than expected voltages due to inductive kick.*

WARNING *Perform a Fuse Check before measuring currents with the internal current shunt. Exercise caution in determining whether a circuit is "live" if the meter does not report a current. This may indicate either a poor connection or a blown fuse.*

NOTE *AC current range is limited by the instantaneous current. Peaks above the listed limits will result in incorrect readings. Derate AC currents with high crest factors accordingly.*

Disconnect power from the circuit to be measured.

Break the circuit and wire the meter in series through the **A** and **C** terminals.

Positive current flows into the **A** terminal.

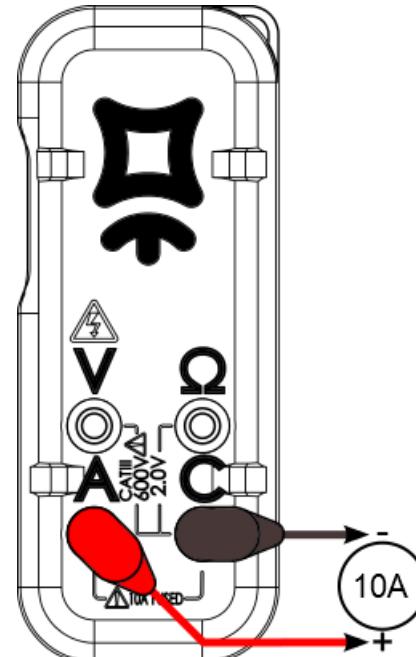


FIGURE 2 BASIC CURRENT MEASUREMENT

MEASURING CURRENT WITH AN EXTERNAL CURRENT SHUNT

WARNING *This measurement mode is capable of measuring currents many orders of magnitude larger than is typically possible with a handheld meter. Exercise caution while interfacing to high ampacity circuits.*

NOTE *The accuracy of this measurement mode depends on the accuracy of the external current shunt used. Account for this accuracy dependency in your measurement certainty.*

The Ω terminal can measure extremely small voltages, with a resolution as fine as 25nV per count and a noise floor as low as 1 μ V. This can be used to with external current shunts to measure currents over a very wide dynamic range. See the ratings section to guide shunt size selection.

It is possible to use the existing wiring for the current shunt, and in doing so take rough current measurements without breaking the circuit.

With very low voltages it is recommended to minimize the loop area of the measurement probes by either twisting them together or using a BNC adaptor.

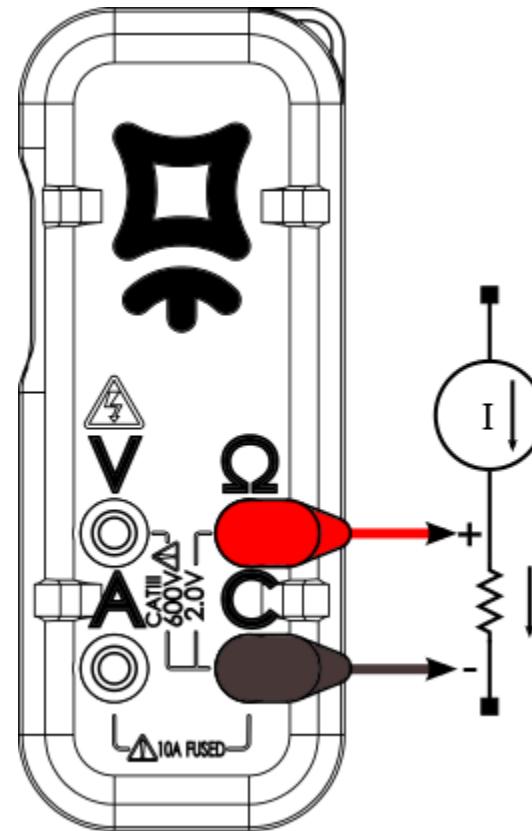


FIGURE 3 EXTERNAL CURRENT SHUNT

MEASURING RESISTANCE

NOTE Do not measure resistance on a live circuit. Doing so will result in incorrect readings and may engage the internal protection circuitry. Should this occur, wait 5 minutes before taking further measurements or accuracy may be compromised.

Resistance is measured between the **Ω** and **C** terminals. Polarization is not important.

The meter uses a 100nA test current in its megaohm ranges and a 100uA test current in its kiloohm ranges.

This measurement mode may also be used for thermistors.

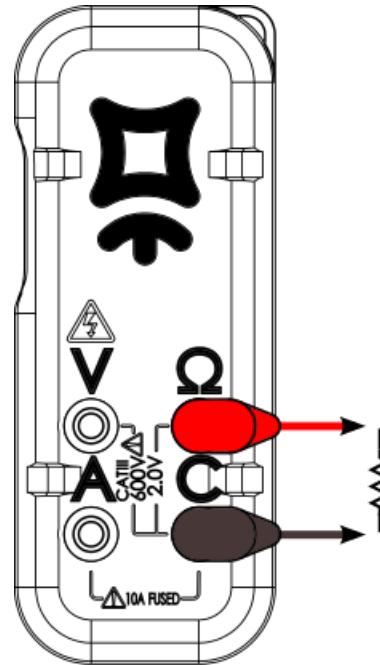


FIGURE 4 RESISTANCE MEASUREMENT

DIODE TESTING

NOTE Do not use the diode test functionality while connected to a live circuit. Doing so will result in incorrect readings and may engage the internal protection circuitry. Should this occur, wait 5 minutes before taking further measurements.

To test diodes or other silicon junction devices, a test current is pushed through the device under test and the resulting voltage is measured.

Positive test current flows out of the **Ω** terminal and into the **C** terminal. To forward bias the diode, connect the Cathode to the **Ω** terminal. For reverse bias, connect the Anode to the **Ω** terminal.

By default the test current is $100\mu\text{A}$, but may be changed to 100nA through the programmer API.

When a second measurement channel is active, the maximum measurable drop is 1V. In single channel mode, this increases to 2.2V

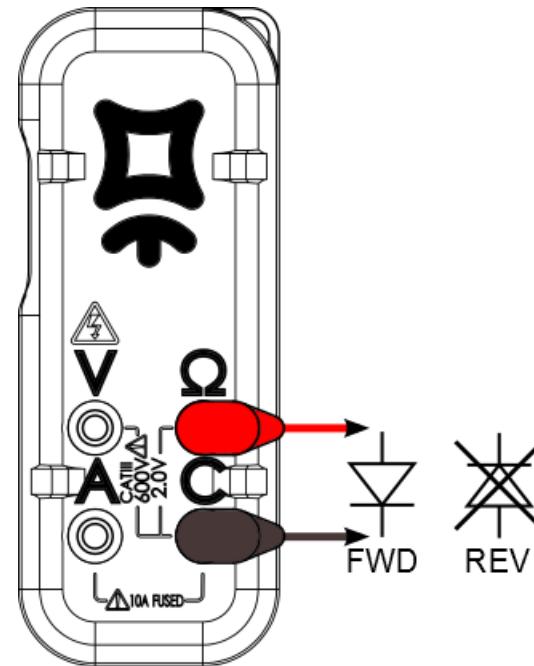


FIGURE 5 DIODE MEASUREMENT

USING A BNC ADAPTER

The 4 terminals are arranged with 0.75" spacing to allow for use of a standard BNC adapter. Measurements using the **A** or Ω terminals can be used with the **C** terminal as usual.

To use a BNC adapter with the **V** input, use the **A** terminal as the common input. The **A** and **C** terminals are internally connected with a low impedance (<20mOhms), so this connectorization develops an error proportional to the current through that path. With 600V applied to the **V** terminal, this is roughly 2 microvolts. Perform a Fuse Check before using this method.

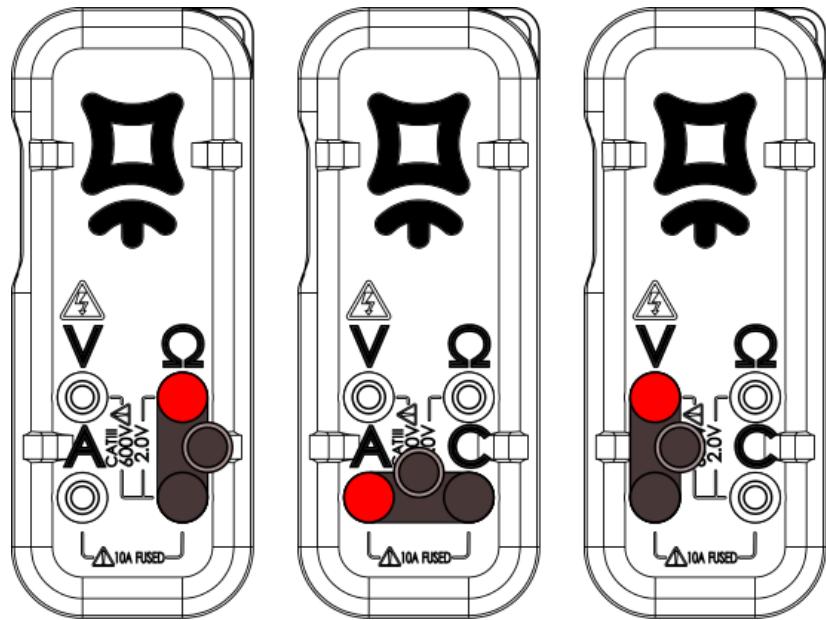


FIGURE 6 BNC ADAPTORS FOR Ω , V, A INPUTS

TWO CHANNEL MEASUREMENTS

Your Mooshimeter is capable of reading any two of its three channels simultaneously. These two data streams may be used independently or they may be combined for advanced measurement types.

NOTE Measurements using the internal current shunt will experience a degree of cross-talk due to the coimpedance of the Common lead. Other measurement types will also experience this cross-talk, but it should be negligible.

MEASURING SMALL RESISTANCES / CALIBRATING A CURRENT SHUNT

The Mooshimeter can be used to measure small resistances in a live circuit by using the current that is already present in the system.

The meter simultaneously measures the current and the corresponding voltage, and then finds the slope to calculate resistance.

This can be done with either the internal current shunt or an external current clamp. Using a current clamp allows the measurement to be done without breaking the circuit and allows for test currents above 10 Amps.

Wire the meter as shown and enable the measurement mode. Apply a test current and run the analysis.

The analysis works best with several points along the curve so it may compensate for offset errors. Therefore, the optimal test current has a large magnitude and a strong time-varying component below 1kHz. For example, an AC system's steady state or a DC system's startup transient may provide sufficient data.

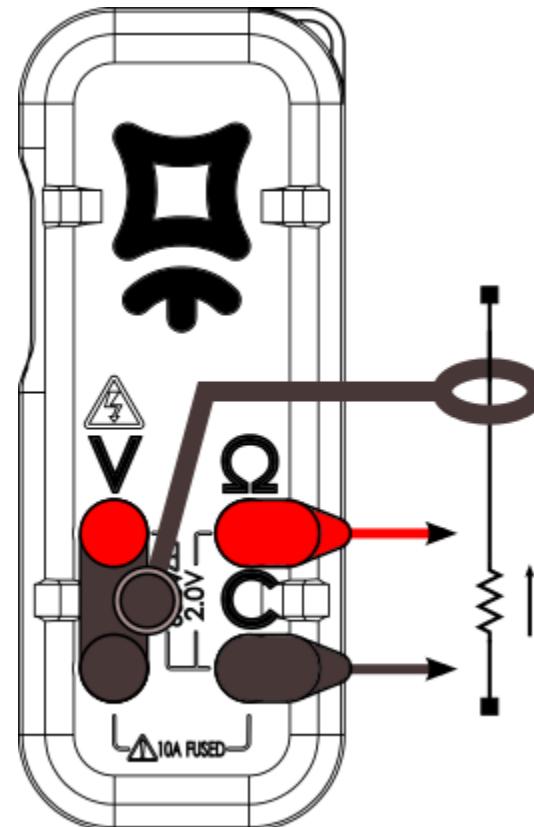


FIGURE 7 CURRENT CLAMP AND CURRENT SHUNT COMPARISON

POWER FACTOR

Power factor compares apparent power and actual power, and is a measure of how effectively a load uses available power. This measurement requires voltage and current measurements.

Current measurement can be done with either internal or external current shunt mode. Power Factor is a “unitless” measure, so the gain accuracy of the measurements does not affect the measurement accuracy. Therefore, the existing wiring can be used as an external current shunt without calibration.

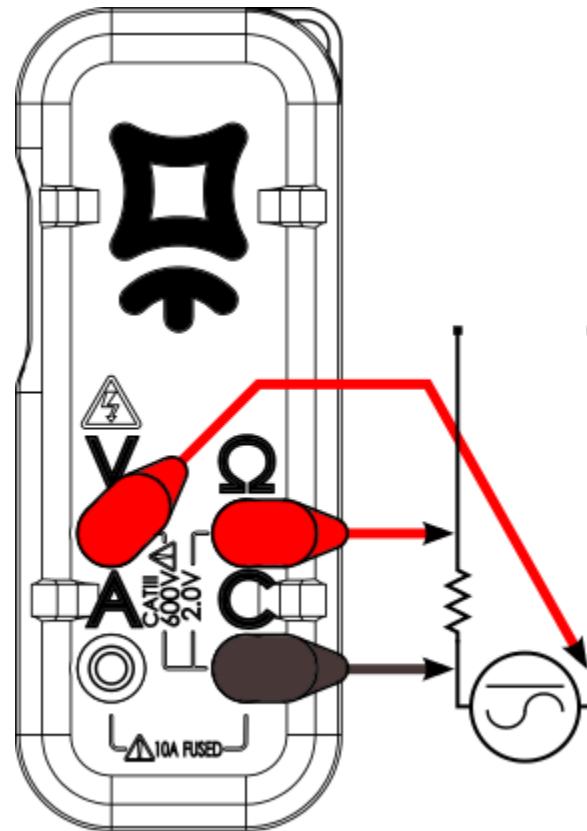


FIGURE 8 POWER FACTOR WITH EXTERNAL CURRENT SHUNT

MAINTANENCE

OPENING THE MOOSHIMETER

WARNING *To avoid electric shock, disconnect test leads from the meter before opening the meter.*

1. Disconnect all test leads.
2. Unscrew both retaining screws from the bottom of the case with a Phillips head screwdriver. (picture)
3. Separate the two halves
4. Taking special care not to bend the circuit board, grasp the circuit board as shown near the connectors and pull it out of the top half of the enclosure.

CLOSING THE MOOSHIMETER

WARNING *Risk of electrical shock. Do not operate the meter while partially disassembled.*

1. Place the PCB in the bottom enclosure half. Use the "J" shaped fin for alignment with the corresponding cut-out in the PCB (picture).
2. Orient the top half as shown (picture).
3. Close the two halves together.
4. Replace both screws. Tighten firmly.

BATTERY REPLACEMENT

1. Open the Mooshimeter per directions above.
2. Remove old batteries.
3. Observe the battery polarity indication on the circuit board.
Insert 2 new AA 1.5V batteries as shown on the circuit board.
4. If you have inserted the batteries with the correct polarity,
the Mooshimeter's LED will blink slowly several times before
turning off. If the light does not blink, check the battery
polarity.
5. Close the Mooshimeter per directions above.

CLEANING

Lightly damped a cloth with water. Gently clean the outside with the damp cloth.

Do not use any solvents or other cleaning agents while cleaning your Mooshimeter. The outer housing is a polycarbonate based material, and may be damaged by incompatible cleaners.

FUSE TEST

WARNING Always perform a Fuse Test before using the internal current shunt measurement mode.

1. Connect the A and Ω terminals
2. In the app, select Fuse Test.
3. If the test fails, immediately replace the fuse.

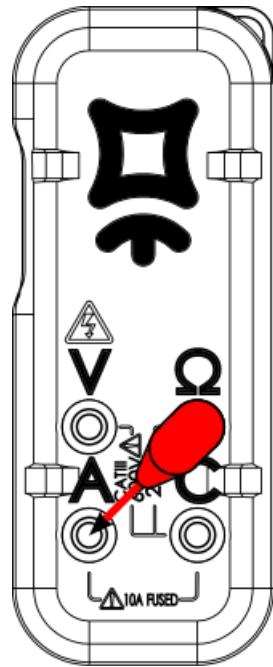


Figure 9 Fuse Test

FUSE REPLACEMENT

WARNING Only use appropriately rated replacement fuse.

1. Open the Mooshimeter per directions above.
2. Gently remove existing fuse from holder.
3. Replace fuse only with appropriately rated replacement.
4. Recommended model:

Reomax 632.300.12, available from Mooshim Engineering

Size 3AG 12A hold 600V 10kA minimum interrupt

5. Close the Mooshimeter per directions above.

REPLACING THE SD CARD

WARNING *To avoid electric shock, disconnect all leads from the meter.*

NOTE *Only use FAT32 formatted SD cards up to 32 gigabytes. Larger SD cards or cards formatted differently cannot be written to.*

1. Open the Mooshimeter per the directions above.
2. Press the SD card further into the slot until you feel a click.
3. Release: The SD card will eject.
4. Remove old SD card and insert new SD card.
5. Push card in with finger until you feel a click.
6. Close the Mooshimeter per the directions above.

RESETTING THE MOOSHIMETER

WARNING *To avoid electric shock, disconnect all leads from the meter.*

1. Open the Mooshimeter per the directions above.
2. Press and Hold the button shown for 5 seconds
3. Close the Mooshimeter per the directions above

GENERAL SPECIFICATIONS

Accuracy is specified for 1 year after calibration within 18 to 28C. Accuracies listed are for single-channel measurements only. Multi-channel measurements may degrade accuracy. For extended specifications visit moosh.im/eter/specs

All AC ranges are RMS assuming a pure sinusoid (crest factor $\sqrt{2}$). Derate ranges linearly with increasing crest factor.

| | |
|---|---|
| Maximum Voltage between any terminal and earth ground | 600V |
| Surge Protection | 6kV peak per IEC 61010-1 600V CATIII |
| Fuse for A input | 12A Reomax 632.300.12 |
| Temperature Coefficient | ??????? |
| Operating Altitude | Up to 2000m |
| Maximum Temperature Range | 5C to 40C |
| Nominal Temperature Range | 18C to 28C. Derate accuracy outside of this range |
| Input Power | 3V 100mA from installed batteries |
| Battery | 2x AA Alkaline, NEDA 15A IEC LR6 |
| Battery Life | 1 year typical standby 50 hours typical continuous active use |
| Size | ? cm x ?? cm x ??? cm |
| Weight | ??? g |
| Safety Compliance | EN61010-1:2010 Measurement Category III 600V EN61010-2-030 |
| Pollution Degree | 2 |
| RF Communications | 2.4 GHz ISM Band Bluetooth Low Energy |
| RF Communication Range | Free Space: Up to 50m |
| Electromagnetic compatibility | FCC Part 15.247 Subpart C ETSI EN 300-328 V1.7.1 EN 61326-1:2013 per EN 55011:2009 + A1: 2010 / Class A Radiated Emissions EN 61326-1:2013 / ETSI EN 301-489-1 V1.9.2 / EN 301-489-17 V2.2.1/ Immunity Testing |

Voltage, Terminal V:

| DC Range | AC Range | Resolution | Noise Floor | Accuracy |
|----------|----------|-------------|--------------|----------|
| 600 V | 600 V | 275 μ V | 9 mV | ?% + ?V |
| 600 V | 430 V | 140 μ V | 5 mV | ?% + ?V |
| 455 V | 320 V | 95 μ V | 3 mV | ?% + ?V |
| 365 V | 255 V | 70 μ V | 3 mV | ?% + ?V |
| 260 V | 185 V | 50 μ V | 2 mV | ?% + ?V |
| 200 V | 140 V | 35 μ V | 1090 μ V | ?% + ?V |
| 135 V | 95 V | 25 μ V | 730 μ V | ?% + ?V |
| 60 V | 45 V | 20 μ V | 610 μ V | ?% + ?V |
| 40 V | 30 V | 10 μ V | 305 μ V | ?% + ?V |
| 30 V | 22 V | 6.4 μ V | 205 μ V | ?% + ?V |
| 25 V | 18 V | 4.8 μ V | 155 μ V | ?% + ?V |
| 18 V | 12 V | 3.2 μ V | 105 μ V | ?% + ?V |
| 14 V | 10 V | 2.4 μ V | 80 μ V | ?% + ?V |
| 9 V | 6 V | 1.6 μ V | 55 μ V | ?% + ?V |
| 1000 mV | 700 mV | 300 nV | 10 μ V | ?% + ?V |
| 670 mV | 475 mV | 150 nV | 5 μ V | ?% + ?V |
| 500 mV | 350 mV | 100 nV | 4 μ V | ?% + ?V |
| 400 mV | 275 mV | 75 nV | 3 μ V | ?% + ?V |
| 280 mV | 200 mV | 50 nV | 2 μ V | ?% + ?V |
| 220 mV | 150 mV | 40 nV | 2 μ V | ?% + ?V |
| 150 mV | 100 mV | 25 nV | 1 μ V | ?% + ?V |

Current, Terminal A:

| DC Range | AC Range | Resolution | Noise Floor | Accuracy |
|----------|----------|-------------|-------------|----------------|
| 10 A | 9 A | 3.8 μ A | 120 μ A | ?% + ? μ A |
| 8.5 A | 6 A | 1.9 μ A | 60 μ A | ?% + ? μ A |
| 6 A | 4.5 A | 1.3 μ A | 40 μ A | ?% + ? μ A |
| 5 A | 3.5 A | 1 μ A | 30 μ A | ?% + ? μ A |
| 3.5 A | 2.5 A | 0.7 μ A | 20 μ A | ?% + ? μ A |
| 2.75 A | 2 A | 0.5 μ A | 15 μ A | ?% + ? μ A |
| 1.75 A | 1.25 A | 0.4 μ A | 10 μ A | ?% + ? μ A |

Resistance

| Range | Resolution | Noise Floor | Accuracy |
|----------------|--------------------|---------------|-----------------|
| 9 M Ω | 1.5 Ω | 50 Ω | ?% + ? Ω |
| 8 M Ω | 1 Ω | 35 Ω | ?% + ? Ω |
| 6 M Ω | 750 m Ω | 25 Ω | ?% + ? Ω |
| 4 M Ω | 500 m Ω | 20 Ω | ?% + ? Ω |
| 3 M Ω | 375 m Ω | 12 Ω | ?% + ? Ω |
| 2 M Ω | 250 m Ω | 8 Ω | ?% + ? Ω |
| 9.6 k Ω | 1.5 m Ω | 48 m Ω | ?% + ? Ω |
| 8.2 k Ω | 1 m Ω | 32 m Ω | ?% + ? Ω |
| 6.1 k Ω | 750 μ Ω | 24 m Ω | ?% + ? Ω |
| 4.1 k Ω | 500 μ Ω | 16 m Ω | ?% + ? Ω |
| 3 k Ω | 375 μ Ω | 12 m Ω | ?% + ? Ω |
| 2 k Ω | 250 μ Ω | 8 m Ω | ?% + ? Ω |

Voltage, Auxiliary Terminal:

| DC Range | AC Range | Resolution | Noise Floor | Accuracy |
|----------|----------|------------|-------------|----------|
| 1000 mV | 700 mV | 300 nV | 10 μ V | ?% + ?V |
| 680 mV | 475 mV | 150 nV | 5 μ V | ?% + ?V |
| 510 mV | 350 mV | 100 nV | 4 μ V | ?% + ?V |
| 400 mV | 275 mV | 75 nV | 3 μ V | ?% + ?V |
| 290 mV | 200 mV | 50 nV | 2 μ V | ?% + ?V |
| 220 mV | 150 mV | 40 nV | 2 μ V | ?% + ?V |
| 150 mV | 100 mV | 25 nV | 1 μ V | ?% + ?V |

| Terminal | Surge Protection | Input Impedance |
|----------|------------------|-----------------------|
| V | 6kV | >10M Ω <200pF |
| Ω | 800V | >100M Ω <200pF |
| | | Burden Voltage |
| A | 10kA 600V | <20 μ V/mA |

Diode Voltage Drop

| Range | Resolution | Noise Floor | Accuracy |
|--------|------------|--------------|----------|
| 2.2 V | 300 nV | 10 μ V | ?% + ?V |
| 1.2 V | 150 nV | 5 μ V | ?% + ?V |
| 825 mV | 100 nV | 3.5 μ V | ?% + ?V |
| 625 mV | 75 nV | 2.5 μ V | ?% + ?V |
| 400 mV | 50 nV | 1.75 μ V | ?% + ?V |
| 300 mV | 40 nV | 1.25 μ V | ?% + ?V |
| 200 mV | 25 nV | 800 nV | ?% + ?V |

RADIO NOTICES

FCC Notice (for U.S. Customers):**This device complies with part 15 of the FCC Rules:**

Operation is subject to the following conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation

Changes and Modifications not expressly approved by Mooshim Engineering LLC can void your authority to operate this equipment under Federal Communications Commissions rules.

This device complies with Industry Canada license-exempt RSS standard(s)

Operation is subject to the following two conditions:

1. this device may not cause interference, and
2. this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. l'appareil ne doit pas produire de brouillage, et
2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.