



Surface DC Voltmeter Model SVM2 Quick Start Instructions

Surface DC Volt Meter Model SVM2 includes:

- 1" Magnetic Spacer attachment
- Spool of wire with end attachments
- Banana Jack
- Alligator Clip

Surface DC Volt Meter Basic Quick Start:

- ***This meter must be grounded to operate.*** Plug the meter into ground (see below) unless you are personally grounded, in which case you simply hold the meter.
- Power on unit and perform a reset: cup your hand over the back of the meter without touching the brass disc; with your other hand, press and release the "reset". The meter should then display zero (+/- a few counts) within a ½ second.
- Taking a reading: (optional) attach the spacer just beneath the brass disc on the back of the meter. The spacer is magnetically held in place.
- With the meter in your hand and the brass disc over the desired test area, take a reading. Keep your fingers away from the test area to avoid accidental discharge. If the disc acquires a charge, the meter will no longer read near zero when your hand is cupped over the sensor. In that case, perform the "reset" procedure again.

How To Ground The Meter:

Using the wire spool: Plug the small end into the left side of the case. The large brass end plugs into the ground jack of a North American AC outlet. If this type of jack is not available, attach either the banana plug or the alligator clip to the large brass end. The alligator clip can clip onto either cold water plumbing (e.g., copper pipe) or to a screw on any electrical face plate (screw must be loosened first). The banana jack can be plugged directly into a ground plug, if the appropriate plug is available.

Surface DC Voltmeter Model SVM2 Full Length Instructions

This type of meter is most often used to measure static charge on a surface or object. For example, the meter can measure the amount of charge from one moment to the next as an object or some material is processed or handled, in order to identify which step in the process is introducing or removing the charge. To perform measurements, either connect the meter to earth ground with the supplied cord (plug it into the left side of the meter), or simply hold the meter if you are already grounded. (The sides and back are conductive.) The cord contains a series 1 megohm resistor for safety. If not using the ground cord, but you are personally grounded, continue to hold the meter, but it is recommended that your grounding have at least 100 kilohm in series for personal safety. If using the supplied ground cord, it can be checked for continuity by touching the large plug directly to the sensor disc while the other side is plugged into the meter. The display should read less than "0.300", or 300 V. If over 300 V, the cord is broken. (If you touch your finger to the disc, there will be an electrochemical reaction that generates typically 0.2 V. This will display as a few kilovolts, but no high voltage is actually present. Therefore it is not very useful to touch your finger to the sensor disc to diagnose your personal ground.)

Turn the meter on and perform a "Reset". To "Reset", hold the rear area of the meter (where the sensor disc is) near a grounded conductor that is large enough to cover most of the "horizon" (imagining that the sensor disc were an eye). This grounded conductor can be your hand. When covering most of the "horizon" of the sensor disc with your hand, make sure that your hand is not actually touching the disc, to avoid the electrochemical effect. Then press and release the "Reset". This process takes about 1/2 second, and it sets the meter so that "zero volts" is the same as ground (+/- a few volts). This step is usually only done once, at the beginning of a measurement session or every time the meter is turned off and back on. (However, the step may need to be performed more often in an ionizing environment or if the disc is accidentally touched.) Occasionally check that the reading remains near zero by covering most of the sensor disc with your hand without pressing "Reset"; if stray charge has gotten onto the disk, the display will not read zero. If this happens, repeat the "Reset" step. The meter also automatically resets at the moment it is turned on. When reset as above, the meter will read absolute voltage with respect to earth ground, which is almost always the preferred mode of measurement. Alternatively, the meter can be reset while held near a charged sample. This is only done if it is more convenient for the meter to read zero near a charged sample (to see small positive or negative trends around zero). However, the meter resolution is 1 V regardless of which type of reset is done.

To measure the charge on an object, point the sensor disc toward the object, without actually touching it to the disc. (An included one-inch spacer rod will be magnetically held in place just below the sensor disc if it is brought near that position. The rod is used to standardize the distance between the disc and the object.) Hold the meter so your fingers don't protrude past the rear face. This prevents your fingers from accidentally discharging the object or altering the reading. At a spacing of one inch, the meter will read the surface voltage of a conductive object, in kilovolts (kV). It also reads the voltage of an insulator, although voltage on an insulator acts differently from voltage on a conductor. (See "Interpreting readings..." below.) The reading is accurate +/-2% provided that the surface is at least 10 inches wide and the spacing is 1". If less than 10 inches wide or at a different spacing, there are formulas that allow estimation the actual voltage of the surface. If the object is less than 10 inches wide, the display will read *lower* than the actual voltage (formulas below). The range is -29.999 to +29.999 kV (-29,999 to +29,999 volts). The increment, or resolution, is .001 kV (= 1 volt). If the voltage goes above 19.999 kV, an automatic safety alarm will sound until the voltage drops back below 20 kV. A high voltage reading will also occur if charge is transferred to the disc. If this happens, the voltage will continue to read high even if the meter is removed from the vicinity of high voltage. In this

case, repeat the "Reset" step. (If the disc is physically touched by a solid, charge transfer of this type may occur. This does not harm the meter, but it will require a "Reset" to continue to make accurate readings. Therefore, avoid touching the disc.)

To test a large area, begin as above, but scan the area (at approximately a constant distance-- The preferred distance is also 1" or 25 mm. The magnetic spacer rod can be used. If the rod hits an obstacle, it will tip and then spring back into place.) The alarm can be set if needed (i.e., if your application has a maximum tolerable voltage, or if you want to hear a tone wherever the static voltage is high). To set the alarm level, press "Alarm Set" and simultaneously press "+" or "-". You can also immediately set the alarm to zero, which mutes it, by pressing "Reset" while "Alarm Set" is pressed. Note that the alarm resets to zero (muted) when power is turned on. If the actual voltage exceeds the alarm setting, the alarm will sound unless the alarm is set at zero. This is true whether the actual voltage is positive or negative. The response is very fast, so you can immediately identify where the "hot" areas are. After scanning, you can press "- Peak Hold" to display the most negative voltage, or "+ Peak Hold" for the most positive. These are the peaks since the last time a "Reset" was done, and their values are *not* erased simply by the act of displaying them; they are only erased (to zero) by doing a "Reset". The response time of these two peak holds is 0.005 seconds (which is much faster than the display update time). These numbers will stay in memory until a more negative (or positive) voltage appears, or until a "Reset" is done or ON/OFF is pressed.

Interpreting readings at other distances or from small sources: There are some subtleties in the physics of electrostatics, and they are mentioned here in order to be technically accurate. Below is some technical information (the difference between measurement of metals vs. insulators, and how to interpret readings at other than 1" and/or from small charged objects). For most purposes, these two paragraphs can be skipped. When measuring the voltage of a metal object or sheet that has *large* dimensions ("large" means with a diameter that is much bigger than the meter case), then the voltage of that object is well-defined and it does not change much if the sensor is moved closer or farther. However, the SVM2 reading *will* change as moved closer or farther, because at constant voltage this reading is inversely proportional to the distance between the sensor disc and the metal surface. The voltage is also well-defined on a *small* metal object if the object is connected by wire to a large piece of metal or a constant voltage source. With this type of small metal object, the voltage remains constant when a grounded sensor or a hand is brought closer because the surface charge (per unit area) on the object *increases* in exactly the right way to keep the voltage constant. This extra charge flows in from the other parts of the metal or through the wire. If the static source is an *insulator* (or an insulator that has small, isolated metal pieces on it), charge cannot flow in this way. Therefore, the surface charge on a given area of an insulator will remain constant when a grounded sensor or hand is brought closer. In fact, if a grounded metal sheet is brought into contact with a charged insulator, the surface voltage of the insulator will drop to zero even though the surface charge remains on the insulator. (If the grounded sheet is then pulled away, the surface of the insulator will return to its previous voltage.) To restate, a large metal surface (or a small metal connected by wire to a large one or to a voltage supply) will have a constant voltage but it will have a surface charge that is *not* constant as either a grounded conductor or the (grounded) meter is moved into proximity. An insulator is the opposite; when a grounded conductor is brought close, the voltage changes while surface charge remains constant.

Suppose the static source being measured is a very large (more than 10 sq meters) metal sheet at voltage -1000 volts. At the standard spacing of $L = 1"$, the meter will read "-1.000" kV, as expected. If the spacing is then increased to 10", the meter will read approximately "-0.100" kV. Therefore, at 10" from a very large metal sheet, the displayed number must be multiplied by 10. In general, when measuring voltage of a very large metal sheet, multiply the meter reading by the spacing in inches to determine the true voltage. In contrast to metal, if the source is a very large *insulating* sheet with uniform charge across the surface, the meter reading will *not* change with spacing; the number displayed is not the "voltage" of the insulator, because an insulator has



no clearly-defined voltage. Instead the meter reading is proportional to the insulator's charge per area, "Q/A". When measured close to a wide, uniformly-charged insulator, the relationship between the SVM2 reading $V_{\text{displayed}}$ (in volts) and Q/A on the insulator surface (in coulombs per cm^2) is $Q/A = V_{\text{displayed}} \times 3.6 \times 10^{-14}$. There is one more variable: the size (diameter) of the static source. Again, there can be a difference between a metal object that is either connected to a voltage supply (or is large compared to the meter case), and an insulating source (or metal that is small and isolated). Call "L" the spacing, in inches, from the sensor disc to the static source (normally, $L = 1"$ or 2.5 cm). Call "D" the diameter of the static source that is being measured (you may have to approximate the value of D if the source is an irregular shape). If the source is either small ($D < 10$ cm) metal that is *not* connected to a voltage source or is an insulator, then $Q/A = V \times 3.6 \times 10^{-14} \times f/(f-1)$, where **f is the square root of $[1 + D^2/4L^2]$** . For example, if the source is a circular metal sheet, sitting by itself (not connected to a wire that could hold it at a fixed voltage), and this metal has diameter $D = 2$ cm, with $L = 5$ cm sensor-to-metal distance, then $f = 1.02$, and $f/(f-1) = 51$. If the display reads "0.200 kV" (= 200 volts), then $Q/A = 200 \text{ volts} \times 3.6 \times 10^{-14} \times 51 = 3.7 \times 10^{-10} \text{ coulombs/cm}^2$. Of course the total charge on the metal is its area, $[1 \text{ cm}]^2 \times \pi$, multiplied by $3.7 \times 10^{-10} \text{ coulombs/cm}^2$. A charged insulator that was 2 cm in diameter and had the same reading would also have the same value of Q/A and the same total charge.

On the other hand, if the source is a metal object with diameter D, with D small (D must be less than 5 cm and also less than L) that *is* connected to a voltage supply via a wire, its actual voltage is $V_{\text{actual}} = 1.4 L^2/D \times V_{\text{displayed}}$, where both D and L are in units of cm.

SPECIFICATIONS: Surface DC Voltmeter Model SVM2	
Range at 1":	0 to +/- 29.999 kV (29999 Volts)
Resolution at 1":	0.001 kV (1 Volt)
Accuracy:	+/- 2% of reading
Capacitance (to ground) of Sensor:	3 nF
Sensitivity if used to sense charge:	3.3 kV/nC
Drift:	< 0.001 kV/ 10 seconds
Leakage Half Life:	> 10 hours
Alarm Range:	.010 kV - 20 kV / mute
High-Voltage Alarm:	Sounds Automatically > 20 kV
Sample Speed:	0.005 sec. (> 98% response for 0.015 sec. pulse)
Auto Off:	If no buttons are pressed in 10 minutes
Environmental:	-1 C to 43 C (30°F to 110°F) 0-85% RH
Size:	4.5 X 3 X 1.2 inches (115 X 72 X 30 mm)
Weight:	160 g (5.5 oz)
Battery:	9 Volt Alkaline (~30 hour life) / "Low Battery" indicator

The warranty period for this meter is one year from the date of delivery.

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