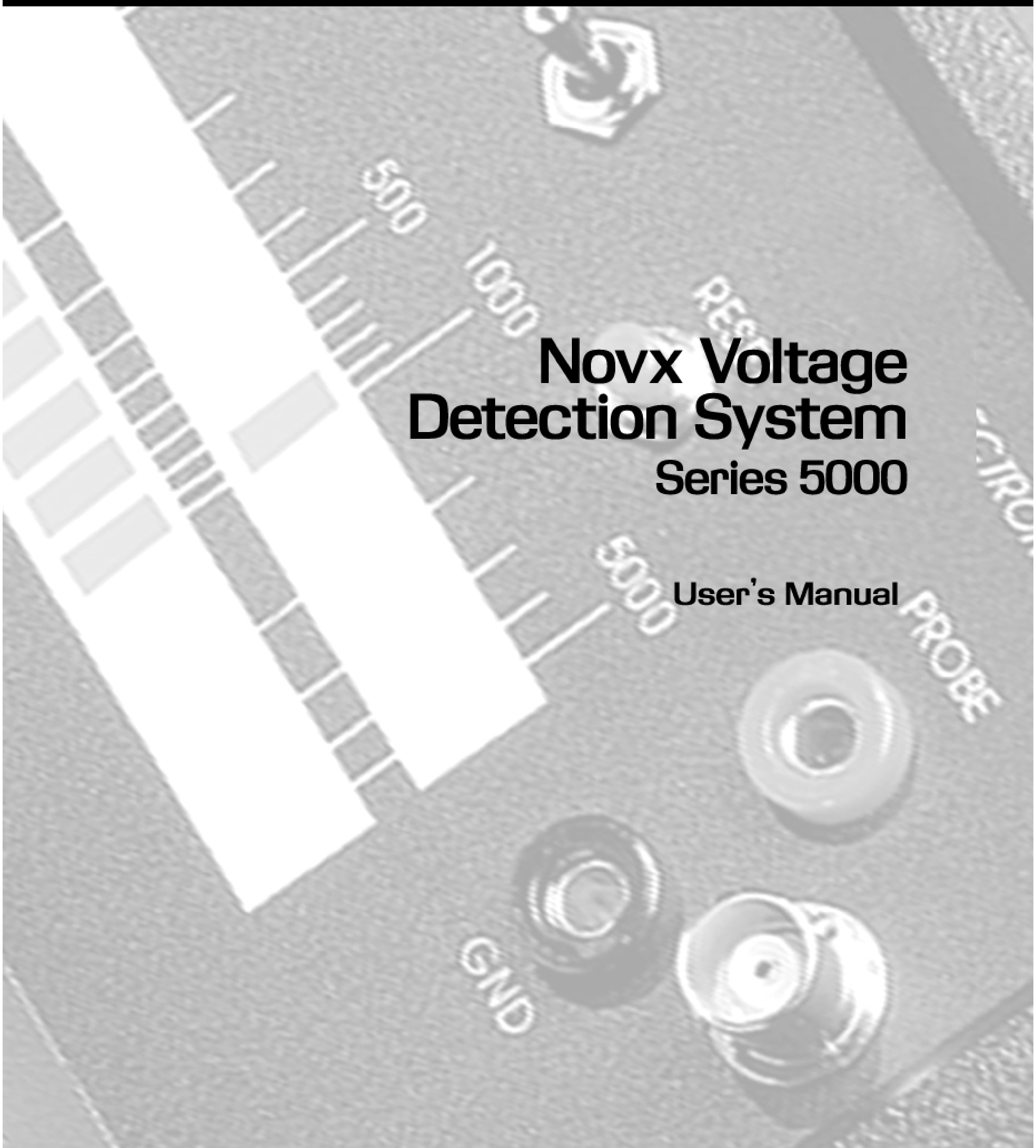
mks
Ion Systems

Novx Voltage Detection System

Series 5000

User's Manual



www.novxcorp.com

19-5000-M Version 1

Series 5000

Voltage Detection System

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1. Product Description

The Novx Series 5000 Voltage Detection System is an advanced portable instrument for use in ESC/ESD auditing, monitoring, and training with direct interface to the Novx Data Acquisition Software and facility monitoring systems. The instrument is used for test and analysis of human body voltage, product performance, real-time equipment performance, ground integrity, and ESD training with the integration of the Novx Series 6150 Training Light Tower. The instrument along with the tower is an excellent marketing tool to demonstrate to customers your continued concern about electrostatic charge (ESC) in your manufacturing environment.

2. System Description

The system is factory calibrated and in most cases, data collection requires only the setting of a few toggle switches. The instrument is designed to be used by regular line employees as well as process engineers. They may be used to check the performance of existing ESD prevention products or to monitor ESC in sensitive work areas.

The instrument is shipped completely assembled and ready for use. Simply attach the power cord to the back of the instrument and set the switches as needed for your particular application.

NOTE: If you are using the instrument for training purposes, your system will also require a Training Light Tower and tower driver.

2.1 Enclosure

The Series 5000 is constructed using the standard Novx stainless steel enclosure with polycarbonate front- and rear-panel overlays. The purpose of the design is to provide ruggedness and cleanliness while remaining attractive and functional

2.2 Rear-Panel

Look first at the rear-panel of the instrument, see Figure 1. This area contains the power connection jack and various instrument settings to be adjusted prior to instrument operation.

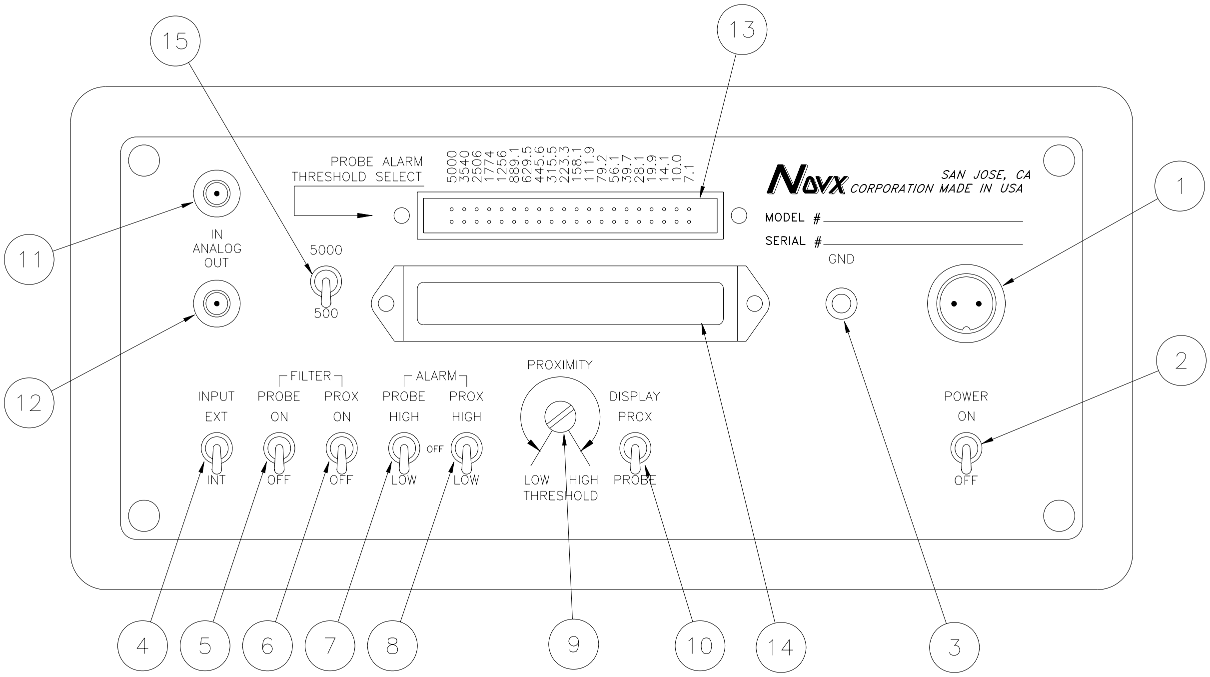


Figure 1: Rear-Panel

NOTE: Novx records the model and serial numbers of your instrument in the upper right corner of the rear panel. You will need this information in the future should you have a warranty claim or need to upgrade the instrument. Novx recommends that you record these numbers in the location shown on the notes page in the back of this manual for that purpose.

2.2.1 Power Cord

Insert the power cord, notched side down, into the power jack (Figure 1, item 1). Make sure the prongs on the jack fit smoothly and fully into the openings in the connector. Turn the locking ring in a clockwise motion to assure the connector will remain securely attached.

CAUTION: Make sure the power switch is in the OFF position before connecting the power cord.

2.2.2 Power Switch

The power switch is located immediately below the power jack (Figure 1, item 2). This is a simple toggle switch. Press up to turn the power on and press down to turn the power off.

2.2.3 Rear Ground Connector

The rear ground connector is one of three ground positions (Figure 1, item 3) the other two connectors are located on the front-panel. You can insert a banana plug, straight wire or spade lug in this rear ground connector.

2.2.4 Probe and Proximity Filter Switches

There are two filter switches that control the sensitivity to higher frequency voltages. The probe filter switch controls the probe side (Figure 1, item 5) and the proximity filter switch controls the proximity side (Figure 2, item 6). With the filter off, the bandwidth is >100 KHz and with the filter on, the bandwidth is 5 Hz. The probe and proximity filter switches can be set independently. Press up to turn the filter on, press down to turn the filter off.

CAUTION: The filters will mask higher frequencies. Therefore, care should be taken if you choose to use the filter function when monitoring a workstation.

2.2.5 Alarm Switches

Two alarm switches control the audible alarms that will sound when the instrument senses an ESC level in excess of a preset limit (Figure 2, items 7 and 8). The probe and proximity thresholds are set independently and can be set at different voltages. Note that the alarm switches have three available positions *high*, *low* and *off*. *High* increases the sound level of the alarm; *low* decreases the sound level; *off* deactivates the audible alarm.

NOTE: The probe audible alarm will sound once each time probe voltage meets or exceeds the preset threshold. If probe voltage remains above the threshold, the alarm will not continue to sound. However, the proximity audible alarm will sound when the proximity voltage meets or exceeds the preset threshold and will continue to sound until the voltage drops below the threshold level.

2.2.6 Proximity Threshold Control

The proximity threshold control is used to adjust the voltage level at which the proximity alarm will sound (Figure 1, item 9). Turn the knob clockwise to have the alarm sound at a higher voltage. Turn it counterclockwise to have the alarm sound at a lower voltage.

NOTE: It is important that you check and adjust the threshold level to suit the needs of your particular environment and application.

2.2.7 Display Proximity/Probe Switch

The display proximity/probe switch is again a simple toggle switch (Figure 1, item 10). Press up for the instrument to display readings related to the proximity monitor channel (general ESC activity in the vicinity of the work area). Press down for a display of the probe monitor channel (ESC generated by the operator at a workstation).

NOTE: The proximity alarm will function regardless of the display switch setting.

2.2.8 Analog In/Out Jacks

The analog in/out jacks use conventional BNC connectors (Figure 1, items 11 and 12). Insert the connector into the jack until the connector slot fits over the jack pin. Turn clockwise until the connector is secure. The analog out function can be used to feed information from the instrument to a chart recorder, a computer or other electronic devices used to store or provide hard copies of data generated by the instrument.

2.2.9 Analog-In

The analog-in function permits ESD data input from an external source such as a workstation instrument. To utilize the analog in function, in addition to having an external data source connected to the analog in jack, you must also make sure that the input Ext/Int switch (Figure1, item 4) is in the up position. This setting informs the instrument that the data source will be external to the instrument.

NOTE: Positioning the input Ext/Int switch in the up position <u>disables the probe side</u> of the instrument. This position tells the instrument that it will be receiving data from an external source rather than from an internal source via the probe monitor. (The proximity monitor is not affected.)

2.2.10 Probe Alarm Threshold Select

The probe alarm threshold select enables you to select the voltage level at which the probe alarm will sound (Figure 1, item 13). A scale of numbers, beginning with 7.1 and ending with 5000, shows the voltage level choices available. A discreet jumper is used to select the desired voltage level. To change the probe alarm threshold, simply remove the jumper that comes with the 5000 and reinsert it at the desired voltage location.

2.2.11 Training Tower Drive Connector

The training tower drive connector enables you to connect the instrument (Figure 1, item 14) to a Novx Series 6150 Training Light Tower (see Training Light Tower section of this manual for a more complete description of this option).

2.2.12 Optional Voltage

An optional switch enables you to setup for a 5000V or a 500V instrument (Figure 1, item 15). Simply toggle the switch up for 5000V or down for 500V full-scale.

2.3 Front-Panel

The front-panel of the instrument provides connections for probe and proximity sensing devices, two additional ground connectors and a clear, easily readable LED display of detected voltage levels.

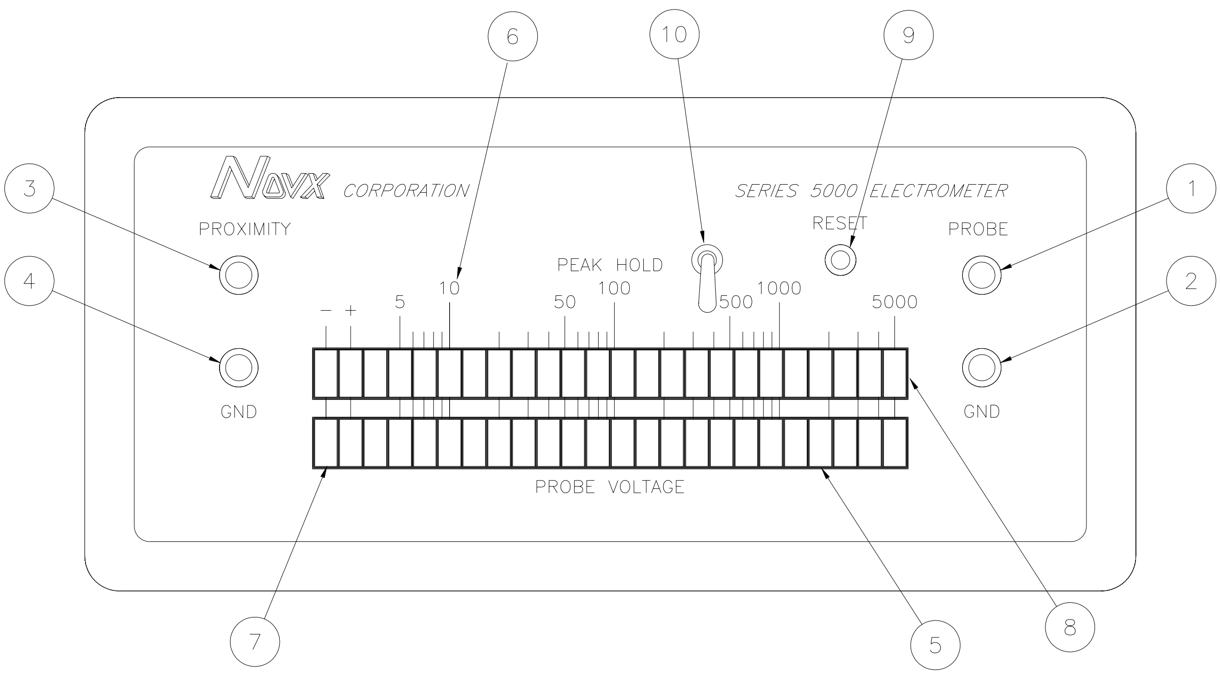


Figure 2: Front-Panel

2.3.1 Probe Jack

The probe jack enables you to insert a single-wire wrist-strap connection to monitor operator-generated ESC (Figure 2, item 1). This is a standard banana jack.

NOTE: This input may be used for other than a probe input, e.g., an antenna input.

2.3.2 Proximity Jack

The proximity jack enables you to insert an antenna to monitor general ESC activity in the vicinity of the workstation (Figure 2, item 3). Again, this is a standard banana jack. NOTE: This input may be used for other than an antenna input, e.g. a probe input.

2.3.3 Ground Connectors

The ground connectors enable you to connect a grounding device for either the probe or proximity monitoring function (Figure 2, items 2 and 4), using a standard banana plug.

2.3.4 Probe Voltage LED Display

The probe voltage LED display shows the polarity and voltage level detected by the instrument (Figure 2, item 5). The left two lights indicate polarity (Figure 2, item 7). The next two spaces are blank, and the balance of the lights display continuous real-time measurement of voltage levels. The first light activates at 7.1V, the second at 10V and so on.

2.3.5 Peak Hold LED Display

The peak hold LED display shows the polarity and *highest* voltage level detected by the instrument (Figure 2, item 8). The left two lights indicate polarity and the lighted section of the peak hold display shows the highest voltage detected since the peak hold reset button was last pressed.

2.3.6 Reset Button

The reset button is used to reset the peak hold display (Figure 2, item 9). Simply press the button to reset.

2.3.7 Optional High Voltage Power Supply Switch

The optional high voltage power supply switch (Figure 2, item 10) may be used for charge plate decay time testing.

2.4 Specifications

The power specifications, footprint and weight of the instrument are shown in Table 1 below.

Input Impedance	>100 GW
Bandwidth/Filter-off	>100 KHz
Bandwidth/Filter-on	5 Hz
Input Voltage (Max)	±10 kV
Input Voltage (Max Display)	±5 kV
Accuracy	5% of actual measurement
Voltage Range	0V to 5000V
External I/O (Analog)	±5V
Power	International
Battery Pack	>8 Hours
Dimensions	4"H x 9"W x 11"D
Weight	3 lbs

2.5 Options

- Low-end Detection Range expanded from 50V-5000V to 7.1V-5000V.
- Proximity Detector allowing detection of static fields within a work area.
- Peak Hold indicator showing the peak voltage and polarity generated at the workstation.
- Remote Probe and BNC Cable assembly for contact measurement of voltages, such as in specific circuits of printed wiring boards.
- Battery Pack for instrument portability and total isolation from AC power.
- Internal Power Supplies for decay time testing (±1200V).
- Training Light Tower and Driver for dramatic and effective demonstrations of the presence of ESC.

Note: For purposes of this manual, we are assuming that all options have been purchased with the instrument.

3. Installation

3.1 Unpacking

When you unpack the instrument, make sure you received all parts as ordered and that nothing has been damaged in shipment. Should there be any missing components or any evidence of shipping damage, contact Novx immediately.

4. Operation

This instrument is most widely used to monitor performance of existing ESD prevention products and to do periodic testing of ESD-sensitive areas in the work environment. It is also the basic platform required for the training instruments that are offered by Novx. Although its detection capabilities are quite sophisticated, the instrument is extremely simple to operate. Once you have determined your application, a few simple switch settings are all that is required to make the instrument fully operational.

Typical applications include monitoring operator-generated ESC at a critical workstation, monitoring general ESC activity at a workstation or using the instrument in conjunction with the Series 6150 Training Light Tower for demonstration and training purposes.

4.1 Switch Settings

The following information explains the various switch settings needed to maximize instrument performance for your particular application and gives detailed information about reading the front-panel LED display.

To use the Novx Series 5000 as a training tool with the Novx Series 6150 Training Light Tower, see the Training Light Tower section. To use the instrument as a workstation monitor, set the switches as follows:

1. Set both the probe filter and the proximity filter to the off position.
2. Set the probe and proximity alarms to either the high or low position, depending on the volume needed to make the alarm audible over ambient noise.
3. Adjust the probe alarm threshold by moving the discreet jumper on the rear panel to the desired alarm voltage.
4. Insert an antenna into the proximity jack on the front of the instrument.
5. Press the display proximity/probe switch on the back-panel, up to the proximity position. This enables the instrument to monitor proximity voltage.
6. Press the power switch up to the on position.
7. Generate detectable voltage by moving your body or shuffling your feet. Watch the front-panel display and note the voltage indicated when the alarm sounds.
8. Adjust the alarm threshold voltage by turning the proximity threshold knob on the back-panel. Turn the knob clockwise to activate the alarm at a higher voltage; turn it counter-clockwise to activate the alarm at a lower voltage.
9. Insert a wrist-strap and connector into the probe jack on the front of the instrument.

10. The proximity antenna should already be in place if you followed the above procedure to adjust the proximity alarm threshold.

11. If you wish to use a chart recorder to provide a permanent record of voltage readings, insert a connector into the analog out BNC connector.

12. Choose either probe or proximity monitoring by adjusting the display proximity/probe switch on the back-panel.

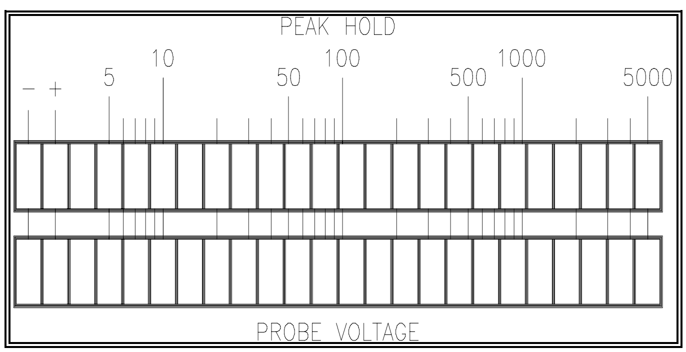
NOTE: The peak hold display will show a light at the negative polarity location (the minus sign) when the instrument is powered up. This serves simply to let you know that the power is on and the display is functioning. Polarity will automatically correct itself as the instrument begins data analysis.

Place the proximity antenna at the desired location, if you are monitoring general ESC activity at the workstation. If you are using the probe monitor, make sure the wrist-strap is clean and securely in place.

4.1.1 Probe Voltage and Peak Hold Scale

The voltage display on the front of the instrument (Figure 3) has a total of 24 LEDs. The left-most element will light to indicate a negative polarity reading. The next element will light to indicate a positive polarity reading.

4.1.1.1 LED Display



The next two LED elements are blanks and do not serve a data reporting function.

The remaining twenty elements indicate the level of ESC detected at any given moment (probe voltage) or the highest voltage reading (peak hold) since the last peak hold reset.

Note: The scale above the LED display range from 5V to 5000V (see Table 2). They are arranged according to a 3 cycle logarithmic scale to show voltage readings. Also, each lighted element indicates a *voltage range* rather than a single number. The chart shows the actual voltage at which the LED element will light, or the *beginning* of the voltage range for that element.

4.1.1.2 Voltage Scale

LED No.	Voltage	LED No.	Voltage
5	7.1	15	223.3
6	10.0	16	315.5
7	14.1	17	445.6
8	19.9	18	629.5
9	28.1	19	889.1
10	39.7	20	1256
11	56.1	21	1774
12	79.2	22	2506
13	111.9	23	3540
14	158.1	24	5000

NOTE: The instrument has been factory calibrated to assure accurate readings. No further adjustment should be necessary. However, ISO certification may require that you have the instrument calibrated at a NIST certified calibration lab once per year. Novx will perform this service for a fee.

4.1.2 Battery Operation

For portable operation, Novx offers an internal NiCd battery pack, available with the instrument. The battery pack requires no external connections, so there are no exterior indications that a battery is present in the instrument, other than the presence of lighted LEDs with no external AC power input. When plugged into an outlet, the instrument maintains a proper battery charge automatically. The battery charge circuitry is “intelligent”, monitoring charge rate and voltage level.

CAUTION: Normally the instrument is grounded through the power cord (if operated with the standard 110VAC transformer) and outlet. When using the battery pack, it is necessary that the instrument be properly grounded to assure accurate readings.

With normal usage, discharge time for the battery pack is a nominal 3 hours. Recharge time is approximately 90 minutes. The instrument automatically maintains battery charge when plugged into an outlet, whether the instrument is switched on or not. The user may continue to operate the instrument during the recharge process.

NOTE: Since there are no external battery condition indicators, there will be no warning when the battery charge is low. If the instrument is operated to the point of charge depletion, generally the audible alarm will start sounding erratically. At that point the instrument becomes inoperable until plugged back in to the AC power source. The instrument will not be harmed if the battery is discharged.

For those users who also have the Novx Training Light Tower, it is important to note that the tower will not function when operating the instrument from the battery pack, it will only function when plugged into AC power.

4.1.3 Remote Probe

Novx offers a remote probe option that enables the user to accurately measure DC (or near DC) voltage at individual components, parts or assemblies. The remote probe is not intended for measuring AC or high frequency signals.

To install the remote probe, insert the probe cable's BNC connector into the Analog-in jack on the front-panel of the instrument or the Analog-in jack (Figure 1, item 11) on the rear-panel. A rear-panel toggle switch selects the Analog-in function (Figure 2, item 4).

The switch should be in the up position for operation of the remote probe or other analog in uses, and in the *down* position for all other operations. This enables the instrument to compensate for circuit differences when the remote probe is in use.

NOTE: Having the toggle switch(s) positioned incorrectly will not harm the instrument. Movement of the remote probe cable may cause a voltage to be indicated because of triboelectric charging within the coaxial cable. The best methodology is to place the probe for a measurement, press the reset button and then take the reading.

Novx incorporates several design features to ensure accurate readings with the remote probe. A special low noise coaxial cable, which will not act as an antenna or significant signal source, is used to connect the remote probe to the instrument. The probe is grounded, and the only active part is the probe tip, which is replaceable. This is a contact probe and is too small to act as an antenna. These features help to ensure accurate, reliable readings for ESD voltages.

CAUTION: The remote probe (with its coaxial cable) is calibrated to a specific instrument and is accurate only with that same instrument. The remote probe is serialized with the same number as the calibrated instrument. For those users having multiple instruments, it is imperative that probes be kept with the proper instrument.

4.1.4 Charge Plate Decay Time Testing

The optional internal high voltage switching power supplies may be used to perform charge plate decay time testing.

1. Connect a charge plate to the instrument using a pair of banana plug wires.
2. Connect one wire to the probe input banana plug (Figure 2:2, item 1), and the ground wire to the gnd banana plug (Figure 2:2, item 2). A coaxial banana to banana cable may be used, but be aware of the capacitance added by the cable.
3. Activate the power supplies by momentarily pressing the power switch (Figure 2, item 10). Press up for ≈+1200VDC or press down for ≈-1200VDC.
4. The decay time may then be measured.

NOTE: Novx also offers a Data Acquisition Software System for use with the instrument. The system consists of a PCMCIA data acquisition card that plugs directly into any PCMCIA slot (most all notebook computers have such slots) and application software which easily collects, displays and stores data for analysis. The software is very user-friendly and offers total versatility in setup and operation.

Information about the Data Acquisition Software System (Figure 4) is available from sales or at www.novxcorp.com.

5. Series 6150 Training Light Tower

The following information guides you through the setup and use of the Novx Series 6150 Training Light Tower. The tower is used in conjunction with the Novx Series 5000 which dramatically improves your ability to demonstrate ESC and its sources to an audience.

One of the biggest issues with ESD training is the ability to physically demonstrate static electricity to employees who will be involved in production processes where static is a major concern. With the ability to demonstrate the cause and effect relationship of ESD generation, personnel become much more conscious of its control in the production environment.

5.1 Specifications

The tower uses an array of 20 lamps to indicate voltage measurements on a 3 cycle logarithmic scale, and 2 lamps to indicate polarity. These lamps operate in parallel with the LEDs on the instrument. The tower is designed to be usable on a table for presentations, see footprint and weight shown below.

Indicators	22 lamps
Dimensions	31H x 8W x 4D
Weight	5 lbs.
Power	Supplied by Instrument

5.2 Setup

The tower requires the instrument as a power and data collection source. The instrument must have the tower drive option installed to be used with the tower.

NOTE: If the instrument does not have the tower drive option, the instrument can be returned to Novx for upgrade. Contact your sales representative for pricing information.

Complete the instrument setup procedure as described in the Series 5000 Setup and Operation section, page 4 of this manual. Pay particular attention to the training tower drive ribbon cable connector (Figure 3, item 14).

1. Connect the ribbon cable, which was included in the package with the tower, to the tower drive connector. This is a keyed, 50 pin ribbon connector. Pressure should be applied evenly across the connector head to assure a solid connection.

2. Press the Input Ext/Int switch down to the Int position.

3. Determine whether or not you wish to use the probe and/or proximity filter option. If you wish to mask higher frequency pulses, press the switches *up* to turn the filters *on*. Remember, probe and proximity filter switches can be set independently.

CAUTION: Use of the probe and proximity filters should be based on a number of factors including the amount of ESC in the room, the level of AC power noise, and the nature of your training presentation.

4. Set the probe and proximity alarm switches. Typically in a training situation, you will want to set these on *high* so the alarm will be audible to everyone in the room.

5. Use the display proximity/probe switch to vary your presentation between demonstrations of ESC generated by a single individual (wrist-strap and connector in the probe side) and static generated in a general area as detected by an antenna connected to the proximity side.

6. Connect the appropriate wrist-strap and/or antenna equipment to the front of the instrument as explained in Series 5000 Setup and Operation section, page 4 of this manual.

7. You are now ready to connect the tower to the instrument. (The connector jack is on the back and at the bottom of the light tower.)

8. Assemble the upper section to the lower section by carefully aligning the two sections, pressing them together and securing into place using the “over-center” latches. Now make the electrical connection by installing the short jumper cable between the two matching connectors and attaching the drive cable between the bottom tower connector and the output connector on the rear of the instrument. When making these connections, align the cable connector to the mating connector carefully so as not to bend any of the pins. Now assemble the base to the tower using the same method described above. The tower assembly may now be set upright on a display table

6. Troubleshooting

The following information addresses questions that may arise in the operation of the instrument. Most problems are the result of incorrect instrument settings or improper setup. However, if you are not able to solve your instrument performance problem after a thorough review of the following information, please contact Novx Customer Service for further information.

NOTHING AT ALL IS HAPPENING THE INSTRUMENT DOESN'T SEEM TO HAVE ANY POWER

- Make sure the wall transformer is connected to the proper AC power, and you have properly inserted the power cord into the power jack. The fit should be snug and the locking ring should turn only a few times until it is finger-tight. If the locking ring continues to turn freely, the power cord is not properly inserted.

- Make sure the power switch is in the up position.

- If the instrument still does not have power, contact Novx Customer Service.

I DON'T THINK THE CALIBRATION IS ACCURATE

Novx takes great care to make sure your instrument is properly calibrated before it leaves the factory. However, if you wish to verify calibration:

- Connect a high voltage power supply to the probe side of your instrument.

- Set the power supply for a variety of voltage levels from 10 to 5000 volts.

- Monitor the LED display of your instrument to make sure it accurately reflects the input voltages.

- Repeat the test for the proximity side of the instrument.

- If you find that the calibrations are not accurate, call Novx Customer Service to arrange a Return Authorization for factory recalibration.

SOME OF THE LEDS AREN'T WORKING

- On both the probe voltage and peak hold displays, the first two LEDs on the left indicate polarity. However, the next two elements are place holders and do not serve a display function. They do not light. If any other elements fail to light, call Novx Customer Service for assistance.

ALL THE PROBE VOLTAGE LEDS ARE LIT AND DON'T SEEM TO CHANGE; BESIDES, THE PEAK HOLD JUST SITS AT 5000V

- Check the rear-panel of the instrument. If you do not have anything plugged into the analog-in jack, but you have the Input Ext/Int switch in the up position, you have effectively overridden the probe side of the instrument. Make sure the Input Ext/Int switch is in the down position (telling the instrument that its data source is internal) unless you are certain you had connected a functioning external signal source to the Analog-in BNC connector.

THE PEAK HOLD STILL SITS AT 5000V

Press the RESET button

I DON'T SEEM TO BE ABLE TO GET A GOOD CONNECTION TO THE LIGHT TOWER

- If necessary lay the tower face-down on a flat surface. Insert the tower end of the cable connector from the instrument. Align the notches (pin #1 and the red wire are to the right as you face the rear of the tower) and apply even pressure until the latch/ejector ears snap into place. This should assure a good connection.

HOW CAN I CHANGE THE AUDIBLE ALARM SETTINGS?

- To change the probe alarm threshold, check the probe alarm threshold select on the instrument's rear-panel. Simply remove the jumper and reinsert it at the desired voltage as shown on the scale above the pins.

- To change the proximity alarm threshold, make sure the display proximity/probe switch is in the up position. Insert an antenna cable into the proximity side of the instrument. While holding the antenna or the cable connector, generate detectable voltage by moving your body or shuffling your feet (optionally you may use a DC voltage source). Watch the front-panel display and note the voltage indicated when the alarm sounds. Adjust the alarm threshold voltage by turning the proximity threshold knob on the back-panel. Turn the knob clockwise to activate the alarm at a higher voltage; turn it counterclockwise to activate the alarm at a lower voltage.

I DON'T THINK MY PROBE ALARM IS WORKING PROPERLY. IT ONLY RINGS ONCE, EVEN IF THE VOLTAGE STAYS ABOVE THE ALARM THRESHOLD

- Your instrument is designed so the probe alarm will sound once, each time probe voltage meets the preset threshold. If probe voltage remains above the threshold, the alarm will not continue to sound. However, the proximity alarm will sound when the proximity voltage meets the preset threshold and will continue to sound until the voltage drops below the threshold level.

I'M NOT GETTING ANY PLOT/PRINTOUT OF MY INSTRUMENT READINGS

- Check the instrument's rear-panel and make sure you have properly connected a BNC connector to the analog-out jack. Insert the connector into the jack until the connector slot fits over the jack pin. Turn clockwise until the connector is secure.

I DON'T THINK THE PROBE IS WORKING

- Sometimes the probe monitor will appear to malfunction because of a faulty wrist-strap. Make sure your wrist-strap is clean and fits properly.

THE VOLTAGE READINGS DON'T SEEM TO BE ACCURATE. I'M SURE THERE IS MORE ESC ACTIVITY IN THE AREA THAN THE INSTRUMENT IS DETECTING

- Check the filter switches on the back-panel of your instrument. Remember, if the filters are engaged they will mask higher frequencies. Press the toggle switches down to the off position.

NOTHING SEEMS TO BE WORKING RIGHT!

- Make sure your instrument is properly grounded. Improper grounding is frequently the cause of erratic readings. Excessively high electrical noise conditions will also result in poor performance.

7. SAFETY

7.1 General Information

Novx Series 5000 is inherently safe under most conditions due to the fact that the instruments are operated by a 14 VAC Class 2 wall mount transformer. No voltages higher than 14 VAC and 21 VDC are present either internally or externally except a voltage that the user may present to the instrument at one of the input terminals. Probe input voltages are reduced through a high resistance immediately inside the front-panel, leaving that as the only point which may be of concern. Since all panels and covers on the instrument are metal, there are no safety issues.

This instrument is intended to measure static electricity. Application of any AC or DC voltage up to 5,000 volts will cause no harm. Static electricity voltages in excess of 5,000 volts will also cause no harm (although the display full scale is 5,000V). If excessively high voltages are applied, the instrument is intentionally designed to allow an "arc-over" to ground immediately inside the front-panel input terminal to prevent damage to the instrument.

CAUTION: Application of excessive voltages (over 5,000 volts) with high amperage available could cause severe damage to the instrument and create a potentially dangerous situation.

7.1.1 Examples

It is not possible to list every situation in which an electrostatic monitoring device should *not* be used. Just remember that the Novx electrometers are designed to monitor *static electricity only*, and that their scale tops out at 5,000 volts. To illustrate applications that should be avoided, this manual lists some of the things these instruments are not designed to measure. These include:

- DO NOT MEASURE the voltages present in a television high voltage power supply which may be 25,000 volts or more.
- DO NOT MEASURE the voltage at a spark plug or coil of an automobile. These voltages are too high.
- DO NOT MEASURE the voltage of high voltage AC power lines. High voltage AC power lines have sufficient amperage available that, in case of a too-high voltage arc-over, or any other fault, the high energy available would cause severe damage to the instrument and create a very dangerous situation.

8. Theory of Operation

8.1 Electrical Charge and Transfer

Electrostatic Charge (ESC) and Electrostatic Discharge (ESD) are charge-driven phenomena.

A body, which in its neutral state has as many electrons (one electron carries one negative charge) as it has protons (one proton carries one positive charge), becomes electrostatically charged when the total number of electrons in that body differs from the number of protons. A body with an excess of electrons becomes negatively charged. If it lacks electrons, it becomes positively charged.

It is widely accepted that a body can acquire or lose electrons, rather than acquire or lose protons. “Charging” a body is thus a phenomenon whereby a body gains or loses electrons.

There are a number of mechanisms by which a body can acquire or lose charge. The most important ones are: triboelectrification, induction charging and conduction charging.

8.1.1 Triboelectrification

Triboelectrification or contact electrification occurs when two materials come into contact with each other, and then separate. One material will “grab” and extract electrons out of the other one at the moment of separation. The material gaining the electrons ends up with a negative net charge, the one losing the electrons becomes positively charged. The interacting materials can either be insulator/insulator, insulator/conductor, or conductor/conductor pairs. In each case, charge separation will occur. However in the case of the conductor/conductor pair, a back-flow of charge will occur at the moment of separation and no net charge will exist after the separation.

A human wearing shoes and walking over an insulated surface such as a carpet is an example of charging by triboelectrification. Each time a shoe sole separates from the carpet electrons will be extracted from one material and gained by the other material.

Another example is that of an integrated circuit sliding down a conductive plastic tube. As the IC slides down the tube, friction occurs between the two materials. One of them will gain electrons, thus becoming negatively charged.

8.1.2 Induction Charging

Induction Charging occurs when a neutral conducting body is brought into the electric field of a charged body. Charge polarization will occur in the conducting body.

While the conducting body is still under the influence of the electric field, the conducting body is momentarily grounded--a neutralizing charge will be drawn up from the earth to annihilate the charge polarization.

When the ground connection is removed and the conducting body is physically moved away from the electric field of the charged body, the conducting body will end up with a net charge which is opposite in polarity to the charge of the charged body.

A practical example of induction charging is when a charged human body walks in close proximity to a printed circuit board which happens to be lying on an insulated surface such as a workbench. In addition, one of the edges of the PCB happens to be very close (millimeters) away from a grounded wire or another conducting structure.

As the charged human body walks past the PCB, charge polarization occurs in the PCB and, if the electrical field is high enough, arcing occurs between the edge of the PCB and the grounded wire. The arc being in fact the “grounding connection” described earlier. As the human being walks away from the PCB, the PCB will be left with a net charge which, in turn, may cause a second discharge if this PCB is handled improperly subsequently.

8.1.3 Conduction Charging

Conduction Charging occurs when two conducting bodies, one with a charge, and a second one without a charge, or with a different charge, are brought into contact, either by touching each other or by establishing a conductive path between the bodies. The charge which existed on the first body will, after contact, be redistributed across both bodies, and the originally uncharged body will have taken on a certain fraction of the initial charge of the first body.

An example of conduction charging is when a charged human being touches an isolated conducting object such as a metal container with explosive powder. Depending on the amount of charge in the human body, arcing may or may not occur at the moment contact is made; but in both cases a fraction of the charge, originally stored in the human body, will have been transferred (possibly with a bang) to the metal container.

In the practical world, Triboelectrification, Induction Charging and Conduction Charging are closely intertwined and sometimes difficult to distinguish.

For example, a person wearing insulating shoes and walking over an insulating surface such as carpet, will cause triboelectrification in the shoe soles. Charge will be trapped at the bottom surface of the shoe sole (the surface in contact with the carpet). Since the human body can be considered as a conductor, the trapped charge in the insulated shoe sole will induce polarization of charge in the human body.

If the person then touches a grounded conductor, whether a hard ground or one with a high series resistance such as the input probe of a instrument, a charge will be drawn from the earth. This is an attempt to neutralize the polarized charge on the human body, and the body will be left with a charge equal in magnitude but opposite in polarity to the charge trapped in the shoe soles. In this case, both triboelectrification and induction charging have taken place.

Another example is a person wearing conductive shoes or an ESD ground strap, walking over an isolated surface. In this case, the charging mechanism is triboelectrification between an insulator (the carpet) and a conductor (the person, including shoes).

8.2 Capacitance

Capacitance is a trait of all bodies, human or otherwise. It can be compared to a reservoir for charges. When charges are stored in this capacitance, a Potential will develop. As an analogy, when you pour liquid into a reservoir, its Level will rise. The smaller the capacitance (reservoir); the higher the potential (level) for a given amount of charge.

The capacitance of a body located totally isolated in outer space is known as the free space capacitance (self-capacitance or isolated capacitance). When the body approaches other bodies or ground planes, other capacitance coefficients come into play: the parallel plate capacitance or mutual capacitance.

For example, a typical human body has a free space capacitance of 118 picofarads. When the body stands on a ground plane on typical insulated shoe soles, its capacitance will increase to 275 picofarads.

Charge, Potential and Capacitance are related by the equation: Charge = Potential X Capacitance (Q=ChV).

One can easily understand that the Charge on a human or other body in motion, as well as its Capacitance, is continuously changing as it interacts with its physical environment. Each interaction of a shoe sole with a carpet, each step, will result in a different triboelectrifi-cation. In addition, each interaction of the foot with the shoe sole, as well as each movement of the shoe sole with respect to the carpet will affect Capacitance. It would be very difficult to measure either Charge or Capacitance; however, it is relatively easy to measure Potential. Novx ESC Monitors are based on this technology of measuring Potential.

8.3 Electrostatic Discharge

Electrostatic Discharge (ESD) is a redistribution of Charge across bodies. This redistribution can be very sudden, intense and short or it can be protracted and fickle.

An example of a sudden redistribution is an arc. One can easily imagine that the sudden flow of a massive amount of electrons can be very destructive to whatever is in its path. It can also be highly unpleasant when this path includes, for example, a human finger.

An ESD event can be very slow, for instance when the charge has to flow through high-value resistors or through a workbench top material with high surface resistance.

An ESD event involving highly conductive bodies and pathways is usually short and intense, and will often result in destruction, latent failures or electromagnetic upset of components and/or systems in the electronics industry.

An ESD event is invariably preceded by an Electrostatic Charge (ESC) cycle. There can be no discharge if charges were not stored previously. The Novx Series 5000 is intended for the analysis of ESC phenomena.

8.4 Measurement Technology

The purpose of the Novx Series 5000 is to measure the amplitude of the potential developed on the human body when a person interacts with his/her everyday Electrostatic environment. The potential is proportional to the amount of Charge on the body, and inversely proportional to its Capacitance. Both Charge and Capacitance change continuously with each step taken, and with every movement of the body in relation to its environment.

The instrument basically measures the voltage across the varying human body Capacitance without discharging the capacitor too quickly. The resistance that the instrument places across this capacitor is in excess of 188 gigaohms.

The evolution of Charge and Capacitance being highly nonlinear, a logarithmic scale is used to display the measured Potential.

Appendix A: GLOSSARY

The glossary applies if the Novx instrument is operated under conditions specified and the instrument is calibrated every 12 months.

1. Input impedance: >100 gigaohms (100,000,000,000 Ohms)

2. Input voltage: ±5000V typ, ±10,000V max

3. Analog-in input voltage: ±5V)

4. Bandwidth: Filter off, 2MHz; Filter on, 5Hz

5. Accuracy: ±5%, optional ±2%

6. Analog out BNC: ±5V

7. Light Tower Drive: 50 pin ribbon connector for Novx Display

8. Operating temperature: 60º F (15º C) to 86º F (30º C)

9. Relative humidity: 80%max. (non-condensing)

10. Storage temperature: -40º F (-40º C) to 158º F (50º C)

11. Warm-up time: Allow 1 hour to stabilize after storage temperature extremes, then power on for 1 hour to attain rated specifications.

12. Power: 100V to 130V or 200V to 240V, 50/60 Hz AC to transformer, 14VAC to instrument.

13. Battery back-up: Internal battery pack and automatic recharge circuitry built-in. Charges and maintains battery whenever AC power is supplied to the instrument.

14. Battery life: Approximately 3 hours, depending on usage and 3 hours recharge time.

15. Size: 4”H x 9”W x 11”D (10cm x 23cm x 28cm)

16. Weight: 3lbs (6.6 kg)