About Physics Playground

Thank you for your purchase from Physics Playground. I, Frederick Graff, am a physics/chemistry teacher here in Tracy California and have been producing high voltage equipment for the past 8 years and truly hope you enjoy your electrostatic generator and lab supplies and find it more than suitable for all your experimentation needs. It has been a personal goal of mine to make science lab equipment that far surpass the integrity of the foreign manufactured items that have flooded the market. These generators are guaranteed to deliver unconventional levels of voltage and current that will do all of the static electricity demos known to high voltage community. Once again, thank you for your purchase and should any questions, comments, or concerns arise along the way, please do not hesitate to contact me at frederick-graff@hotmail.com or (209)914-2619.

How a Van de Graaf Generator Works

VDG’s operate just like a conveyor belt for charge in the sense that they pick up negatively charged electrons from the bottom and take them to the top where the electrons are dropped off. The mechanism that allows the electrons to be picked up from the bottom is that the lower roller is made from material that can develop a positive charge that in turn attracts the electrons from the bottom of the comb and flings them toward the belt which then transports them to the top. When the nega-
How a VDG Works (cont.)

-tive electrons reach the top they are re-
pelled off the belt by the top roller which 
is made from a material that can produce 
a negative charge. Factors that affect the 
strength of a VDG would be the belt 
speed, the ability of the rollers to develop 
positive and negative charges (refer to 
triboelectric series), and the size of the 
sphere which hold the electrons.

Van De Graaf AC High Current Assembly

For 350 KV, 500 KV, 700 KV, and 1 MV Generators

STEP 1) Attach the bottom comb to the 
base and then connect the ground lead to 
the grounding bolt and wing nut that is 
located about 1 inch behind the motor. 
The larger 700KV model will have two 
grounding bolts that an additional ground-
wire will be used to connect the two.

STEP 2) Bolt in the acrylic tube to the 
base of the VDG using the metal or nylon 
machine screws and wing nuts. Be very 
careful that the screws are not made too 
tight in order to prevent damaging the 
tube. Some designs will come with the bot-
tom insertion hole tapped.

STEP 3) Attach the top aluminum support 
system using the smaller nylon screws and 
nylon wing nut. All VDG’s will have the 
aluminum support systems on the inside of 
the tubing accept the 700 KV VDG. Once 
again, do not over tighten the screws oth-
erwise the tubing will crack.

STEP 4) For optimal performance prepare 
the belt and both rollers by cleaning them 
with lightly soaped water to remove any 
form of dirt or oil and then dry them us-
ing a paper towel. For best results, rinse 
the belt and rollers with distilled or fil-
tered water.

STEP 5) The static belt is fastened by first 
attaching the top roller and then feeding 
the belt down through the tube. From the 
bottom opening, reach up and grab the 
belt and place the bottom nylon roller 
through the belt and then connect the 
roller into the bottom insertion holes. 
While connecting the roller, always keep 
one hand through the belt incase the roller 
slips from you. There will be a signifi-
cant amount of tension within the belt 
system.
Van de Graaf Assembly (Cont.)

STEP 6) The top and bottom metal combs should be spaced about a 1/4 inch from the belt and facing toward the belt so that they may spray the electrons to and from it. The combs should never touch the belt during operation and will tear the belt if they do.

STEP 7) Fasten the dome on to the aluminum support system using the nylon thumb screw. For the 350 KV VDG, the dome should press down on the insulation to prevent leakage.

VDG Operation: Before turning on, make sure the speed control is at least 6 feet from the generator. If the speed control is touched by a person near the generator, the control will be destroyed. For this reason, the speed controls will not be covered under warranty.

When testing the VDG, it may take up to 10 minutes before it develops a charge considering that the belt are rollers were cleaned. To accelerate the process blow a hair dryer up the tubing to push out any moisture. This will especially be necessary on high humidity days.

300 KV and 350 KV DC Powered Assembly

Step 1) The 300 KV and the 350 KV DC powered generators will come fully assembled. To insure a more efficiently operating VDG, it is advisable to first clean the belt and rollers with lightly soaped water and then rinse with a distilled or filtered water.

Step 2) Once the belt is reconnected, make sure that the combs are spaced about 1/4 inch away from the rollers. The VDG will operate more efficiently as the combs are adjusted closer, however just do not let the combs touch the rollers otherwise they will destroy the belt.

Step 3) Attached to the bottom comb will be a ground wire that is used to transport electrons to the bottom comb during operation. This ground wire should be clamped to an item in the area that is Earth grounded such as a sink, gas port, or metal structure. The ground wire may even be held onto, however it will not work as well as an Earth ground.

STEP 4) The DC powered VDGs do not come with a power supply because they are designed to use the operators power supply of choice. When selecting the power supply you will need at least 2 amps of current at 4 volts and not exceeding 9 volts. Below is a list of preferred power supplies:

Battery Power Supplies:
- Any 6 Volt battery
- ***www.allelectronics.com (highly recommend the 6V 4.5 AH GEL CEL)***
- 4 Cell AAA battery holder

AC to DC Power supplies:
Most AC to DC power supplies may be found on eBay for less than 5 dollars with shipping included.
- 5V at 2A - 3A
- 6V at 2A - 3A
- 7V at 2A - 3A
Any lab power supply that can deliver at least 2 amps of current.

These VDGs are designed to operate at much higher currents and voltages than the typical manufactured units, therefore the AC to DC plug in power supplies may easily be damaged if they are interrupted by the current produced from the VDG. To avoid damaging the plug in power supply:

- Do not touch power supply while touching the generator.
- Keep power supply at least 4 feet from generator.
- Never Allow the grounding wire to touch the power cord wire.

*If you are using a DC battery to power the VDG, there are no constraints.*

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**All VDG Safety**

1) Always keep VDGs away from people with pacemakers.

2) Keep VDGs away from electronics. Do not use VDG's on the same breaker as computers and AV equipment.

3) To prevent damaging the speed control, keep it at least 6 to 8 feet from the VDG. If you feel sparks on the handle of the speed control, move the control back further.

4) Avoid making human chains that will produce large discharge currents and voltages.

5) Avoid using high voltage capacitors around the VDG.

6) Arcs from VDG will produce small welts on body.

7) Operate in a well ventilated area due to the ozone produced by VDG.

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**All VDG Maintenance**

1) Both belt and rollers should be washed with lightly soaped water after every 2 hours of use. Do not allow water to get on the bearings while washing. VDGs will attract dust due to the high voltage.

2) When cleaning the VDG, only use soap and water. Acetones, alcohol, and thinners will crack the acrylic.

3) The VDG Latex belt will oxidize in UV light. When finished using, place the VDG in a light protected area or remove the static belt.

4) Should the belts ever tear, use “Gorilla Super Glue” to re-mend if salvageable.

5) The top roller should be recoated with Pliobond after 20 hours of use.
VDG Trouble Shooting

Van de Graaf generators have two main obstacles that will stop them from working being oil and water. When the VDG first arrives, it is always necessary that the rollers be rewashed and dried before using so that any oil that may have contaminated the system during shipping be removed. Once the VDG is operating, the high voltage produced will continue to attract dust and any suspended oils from the air, therefore it is necessary that the system be regularly cleaned to remove these contaminates.

If the system is washed and it still does not produce a spark, allow it to operate for at least 10 minutes especially for the newer VDG so that the rollers may wear into the belt. Many often find that the more they use the VDG, the stronger it gets. To accelerate the VDG to full operation, it is best to blow a hair dryer through the bottom opening while the VDG is running. Should the system still be struggling to produce high currents, rewash the belt and rollers though it is rare to have to do so.

Humidity will significantly deter the performance of the VDG if not completely stop it from producing a charge. All of the Physics Playground generators are designed to operate in very high humidity conditions up to 85%. To alleviate humidity conditions, a hair dryer may be blown up the tubing while in operation in order to push out moisture or the unit may be ran in a air conditioned environment.

Quick Tips:
- Keep the VDG Clean of oil and dust
- Allow up to 10 minutes of run time after cleaning belt and rollers for full current to develop.
- Use a hair dryer to push out humidity.

Van de Graaf Generator Demos

1) Insulate yourself using a milk crate and then either place your hand on the generator or point an unfolded paper clip at the generator (this works well for those who do not want to touch it). Look up and you will see your hair standing on end. While being charged, try the following:
   - Open your hands and then close them. There will be a very weird feeling all over your body as the voltage jumps from 400KV to 100KV and then back again.
   - Point at your neighbor. You will be shooting electrons at them.
   - Hold a fluorescent tube and have another touch it to light it up or you point at the tube while your neighbor holds it.
   - Put pie pans on your head while being charged and then let them go.

2) VDGs are also ideal for making electrostatic motors. You may find more on electrostatic motors at www.physicsplayground.com

3) VDGs maybe used for particle accelerators, enhancing plant growth, separating fine particles, high voltage effects, and haunted house props plus much more.
Physics Playground is a small and growing business that has been started by Frederick Graff, a mechanical engineer graduate from Penn State and employee of United Technologies that had taken on the passion of education in hope to inspire and guide the youth into the sciences. The origin of the business was rooted in the lacking California educational budget to adequately supply the equipment to operate a physics and chemistry lab class. To supplement the equipment such as acceleration ramps, power supplies and electrostatics, Frederick began the task of building his own lap equipment, which eventually brought forth the first Graff made VDG as seen in the photo below. Years later with hundreds of hours of perfecting the static generator design, Physics Playground is pleased to present a product listing of the strongest and most efficiently operating VDG’s the market has to offer. Many thanks for your purchase and be sure to always pass on the love for science and search for the greater truth!

Physics Playground Warranty and Replacement Parts

Warranty: Physics Playground generators and high voltage equipment is covered under a one year warranty accept for static belts and speed controls (or AC to DC converter power supplies) Sign of rough use such as dropping, over tightening hardware, and exposure to caustic chemicals will dismiss the equipment from eligibility of the warranty.

Prior to sending the replacement part, the buyer must email a photo of the damaged part to frederickgraff@hotmail.com for verification. All replacement parts will be shipped within 4 business days.

Consumable Parts: Please visit Physics playground for replacement parts. Both belt material and pre-made belts will be sold on the website. For those who wish to mend their own belts, the belt sizes are listed below.

- 300KV and 350KV DC Powered VDGs: 
  (2 in x 35 in)
- 350KV High Current VDG: 
  (3.5 in x 35 in)
- 500KV and 700KV High Current VDGs: 
  (4.5 in x 47 inch)