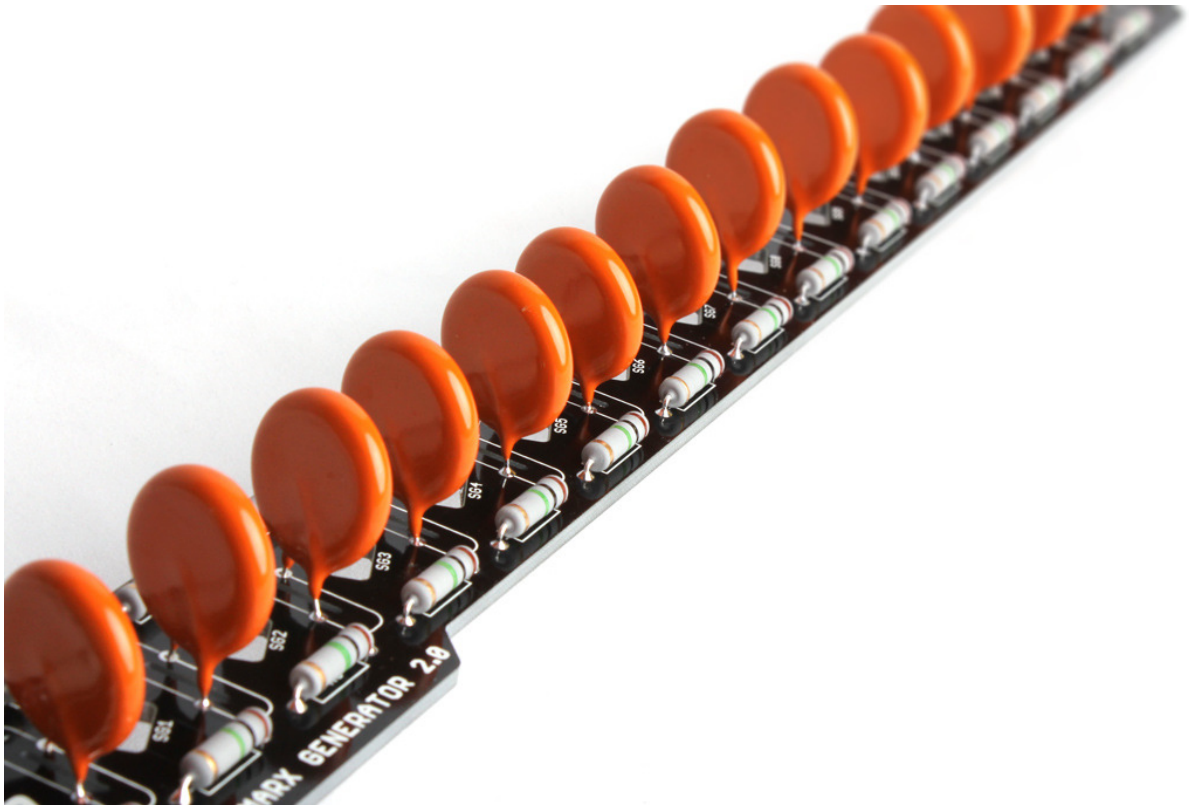
Marx Generator 2.0 Kit



Instruction Manual

Eastern Voltage Research, LLC

AGE DISCLAIMER

THIS KIT IS AN ADVANCED, HIGH POWER VOLTAGE GENERATOR DEVICE. IT IS INTENDED FOR USE FOR INDIVIDUALS OVER 18 YEARS OF AGE WITH THE PROPER KNOWLEDGE AND EXPERIENCE, AS WELL AS FAMILIARITY WITH LINE VOLTAGE POWER CIRCUITS.

BY PURCHASING, BUILDING, USING, OR OPERATING THE MARX GENERATOR 2.0 KIT, YOU ACKNOWLEDGE THAT YOU ARE OVER 18 YEARS OF AGE, AND THAT YOU HAVE THOROUGHLY READ THROUGH THE SAFETY INFORMATION PRESENTED IN THIS MANUAL.

THIS PRODUCT SHALL NOT BE USED AT ANY TIME BY INDIVIDUALS UNDER 18 YEARS OF AGE OR BY ANYONE UNFAMILIAR WITH THE SAFETY ASPECTS OF THIS DEVICE.

WARNING – HIGH VOLTAGE OUTPUT

BOTH THE INPUT AND OUTPUT OF THIS DEVICE CONTAINS HIGH VOLTAGE. THE INPUT CHARGE VOLTAGE CAN APPROACH 10KV, WHILE THE OUTPUT HIGH VOLTAGE DISCHARGE CAN EXCEED 100KV DURING OPERATION. EXERCISE EXTREME CAUTION DURING OPERATION.

EMI CONSIDERATIONS

THE MARX GENERATOR 2.0 IS A HIGH VOLTAGE, IMPULSE OUTPUT DEVICE. THIS DEVICE CREATES HIGH VOLTAGE OUTPUT PULSES WITH ULTRA-FAST RISE TIMES THAT CAN OUTPUT HIGH BANDWIDTH RADIATED OUTPUT NOISE, MUCH IN THE SAME WAY THAT ELECTROMAGNETIC PULSE DEVICES OPERATE, AND THIS NOISE CAN COUPLE INTO NEARBY POWER CORDS, ALARM WIRING, NETWORK CABLES, ETC… AND POTENTIALLY CAUSE DAMAGE TO SENSITIVE ELECTRONICS.

IT IS THE RESPONSIBILITY OF THE END USER / CUSTOMER TO COMPLY WITH ALL FCC OR RELATED EMI / EMC REGULATIONS AND TO ENSURE THAT PROPER FILTERING AND SHIELDING IS UTILIZED TO PREVENT AND / OR MINIMIZE THE EFFECT THE MARK GENERATOR 2.0 HAS ON OTHER ELECTRONIC, INCLUDING COMPUTER, EQUIPMENT IN THE VICINITY OF OPERATION.

EASTERN VOLTAGE RESEARCH IS NOT RESPONSIBLE FOR ANY DAMAGE THE MARX GENERATOR 2.0 MAY CAUSE TO OTHER ELECTRONIC AND SIMILAR EQUIPMENT AND MAKES NO CLAIMS REGARDING THE COMPATABILITY OF SUCH EQUIPMENT WHEN OPERATING IN THE GENERAL VICINITY OF THE MARX GENERATOR 2.0 OR WHEN SHARING THE SAME ELECTRICAL CIRCUIT AS OTHER ELECTRONIC EQUIPMENT.

SAFETY AND EQUIPMENT HAZARDS

PLEASE BE SURE TO READ AND UNDERSTAND ALL SAFETY AND EQUIPMENT RELATED HAZARDS AND WARNINGS BEFORE ASSEMBLING AND OPERATING THE MARX GENERATOR 2.0 SYSTEM.

PACEMAKER WARNING

THIS DEVICE WHEN OPERATING WILL PRODUCE ELECTRICAL AND MAGNETIC FIELDS. EXPOSURE TO THESE FIELDS SHOULD BE LIMITED. DO NOT USE THIS KIT IF YOU HAVE AN IMPLANTED PACEMAKER OR OTHER BIOMEDICAL DEVICE OR ANY IMPLANTED METALLIC MATERIALS.

ELECTRICAL HAZARD

This circuit utilizes dangerous line voltages up to 115VAC and produces output voltages approaching 100kV. Failure to handle this circuit in a safe manner may result in serious injury or death!

ENERGY STORAGE WARNING

This device contains high voltage energy storage capacitors. Please allow at least 5 minutes from the time the unit is unplugged to the time you handle or move the Marx Generator 2.0.

FIRE HAZARD / EXPLOSION HAZARD

The high voltage output of the Marx Generator 2.0 may ignite flammable liquids or gases that may be in the vicinity of the unit during operation. Ensure that no flammable solids, liquids, or gases are the vicinity when this unit is operating.

SAFETY GUIDELINES FOR LINE POWERED EQUIPMENT

The electronic kit you purchased utilizes line voltages (115VAC) and also contains circuitry that produces output voltages in excess of 340VDC. Normally, consumer electronics equipment are safely enclosed to prevent accidental contact. However, the kit you have purchased does not come with an enclosure, and must be handled and operated with this in mind. Voltages exceeding 35V pose a safety hazard and depending on overall conditions and your general state of health, voltage and current levels have the ability to serious harm or even kill.

The following guidelines are to protect you from potentially lethal electrical shock hazards as well as the equipment from accidental damage.

It is also important to note that the danger isn't limited to only your body providing a conductive path, namely your heart. Any involuntary muscle contractions caused by an electrical shock, while perhaps harmless in themselves, may cause the person to be injured by falling, hitting a body part on something sharp, etc….

The purpose of these set of guidelines is not to frighten you, but rather make you aware of the appropriate precautions needed to safely build and operate this electronics kit.

- Perhaps, the number one rule – Don't work alone! If something does happen, it is extremely important to have someone nearby to render assistance or to call for help.
- When working on energized equipment (namely those that are line powered), always keep one hand in your pocket. This ensures there is not a complete electrical path through your heart providing you accidentally make contact with live voltage.
- Wear footwear with non-conductive (rubber) soles. Do NOT work on line powered or high voltage equipment in barefeet.
- Always wear eye protection. Power semiconductor devices, and capacitors do have the potential to explode unexpectedly and project sharp fragments across the room.
- Always work in a clean, open area. Avoid working in cluttered spaces, especially if there are grounded objects nearby that could complete a circuit path in the event you make accidental contact with live voltage.
- Avoid wearing any kind of jewelry or other articles that could accidentally contact circuitry.
- Never operate your PC boards on top of conductive tables, or other conductive objects. PC boards should ALWAYS be supported by the provided stand-offs or placed on top of a non-conductive tabletop or other material.
- ALWAYS allow proper time for any large electrolytic or other high voltage capacitors to discharge after removing power prior to working or touching any

circuit. ALWAYS use a multimeter to measure the voltage across large capacitors after power is disconnect to ensure the voltage has properly bled off.

- Use an isolation transformer if there is any chance of contacting line powered circuitry. A Variac is NOT an isolation transformer!
- Finally, if your kit involves a Tesla Coil – NEVER touch or attempt to draw an arc with an object from the output of a Tesla Coil. The output of a Tesla Coil poses not only an electrical hazard, but also a burn hazard. The output from even the smallest solid state Tesla Coil can cause serious burns. Always operate the Tesla Coil at a safe distance.

SAFETY GUIDELINES – ELECTROMAGNETIC FIELD OUTPUT

DO NOT USE THIS KIT if you have an implanted biomedical device such as a pacemaker!

- Electromagnetic fields are produced when the Tesla coil is operating. Ensure that you and others are always at least five feet away from the devices during operation (small kits), and farther away with some of the larger kits such as the miniBrute Tesla Coil kit.
- Avoid contact with metallic objects. This is mostly important for the smaller CW based Tesla coils such as the SSTC 1.0 or Class-E Audio Modulated Tesla Coil. What happens is that the electromagnetic fields cause charge to build up on your person and any contact with something metallic will initiate a potential RF burn to occur. The burns are on the magnitude of an electrostatic shock – they are rarely harmful, but they can surprise you and give you a small instant of localized pain – again similar in receiving a electrostatic shock. Maintaining at least five feet away from the Tesla coil will prevent his from occuring.
- DO NOT use this kit if you have an implanted biomedical device.

Introduction to the Marx Generator 2.0 Kit

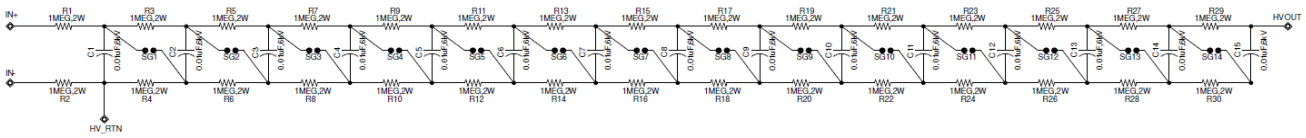
Thank you for purchasing the Marx Generator 2.0 Kit. A Marx Generator circuit is a method of producing very high impulse voltages with extremely fast rise-times. These devices are single-shot in nature and are very close to simulating real lightning, unlike Tesla Coils which generate continuous AC output voltage.

A Marx Generator works by charging up many high voltage capacitors in parallel, and then discharging them in series. This particular device has fifteen (15) stages of 6kV capacitors. Therefore, if each stage capacitor is charged up to 6kV, then when the capacitors discharge in series, the resulting output voltage would be theoretically 15 * 6kV which is 90kV!

Each stage consists primarily of a capacitor and a spark gap. The spark gap is spaced to fire at a preset voltage – for example 6kV. So once a DC charging voltage is applied to the input of the Marx Generator, each stage capacitor will begin slowly charging up towards the maximum input DC voltage, which in this case is 6kV. Because each stage has a 1 MEG series limiting resistor, the charging may take a second or two depending on the output current capability of the input voltage source. Once the voltage across each capacitor and spark gap exceeds the voltage breakpoint of the spark gap, the spark gap will fire and conduct, and thus create a cascading effect which will cause all spark gaps to fire and conduct, and thus place all fifteen (15) of the parallel capacitors in series and thereby stacking the total voltage across all the capacitors to the output of the Marx Generator.

Marx Generator 2.0 Schematic

Thank you for purchasing



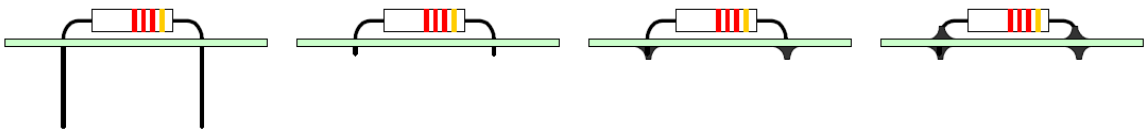
Please read this manual in its entirety before building, testing, or operating your kit!

Kit Building Tips

A good soldering technique is key! Let your soldering iron tip gently heat both the wires and pads simultaneously. Apply solder to the wire and the pad when the pad is hot enough to melt the solder. The finished joint should appear like a small shiny drop of water on paper, somewhat soaked in. If the pads have not heated up sufficiently, melted solder (heated only by the soldering iron itself) will form a cold solder joint and will not conduct properly. These cold joints appear as dull beads of solder, and can be easily fixed by applying additional heat to the pad and wire. All components, unless otherwise noted, should be mounted on the top side of the board. This is the side with the silkscreen printing.

When installing components, the component is placed flat to the board and the leads are bent on the backside of the board to prevent the part from falling out before soldering. The part is then soldered securely to the board, and the remaining lead length is clipped off. It is also extremely important to place the components as close to the board as possible. This is necessary for proper operation over the wide frequency range of the various kits we provide. Also be sure that component lead lengths are always as short as possible. This will avoid adding any stray capacitances or inductances that can be detrimental to circuit operation.

An alternative approach (which is actually the one I use) is to install the component into the board and then apply a piece of masking tape on the topside to the hold the component in place temporarily. The leads on the backside of the board are then trimmed leaving about 0.10" lead protruding through the backside of the board, and then soldered from the backside. You can then remove the masking tape, and finally apply a small amount of solder on the top to complete the joint on both sides. This is shown in the figure below.



Marx Generator 2.0 Parts List

RESISTORS

❒ 15 1Meg Resistor, 2W (brown-black-green), R1-R30

CAPACITORS

❒ 15 0.01uF, 6kV Capacitor, Ceramic, C1-C15

MISCELLANEOUS

❒ 28 Nuts, Brass, Acorn, 4-40, SG1-SG14
❒ 2 Mounting Brackets, 6-32
❒ 1 Marx Generator 2.0 PCB Board

REQUIRED, NOT SUPPLIED

❒ 1 Input HV Supply, 1kV-6kV
❒ 1 Misc. Bus Wire for output electrodes
❒ 1 Feeler gauge (or shim) for setting spark gap distances

OPTIONAL, BUT RECOMMENDED

❒

Marx Generator 2.0 - Component Layout Diagram (Top and Bottom)

Marx Generator 2.0 – Mounting Provisions

The Marx Generator 2.0 kit has two mounting brackets located on the bottom end of the PCB board. These can be attached directly to the mounting base of your choice and oriented vertically for maximum visual effect. Mounting the device in air vertically will also reduce the amount of high voltage coronal losses.

KIT Building Instructions

Now we will begin building the kit. There are just a few more important things to know before we install the first components.

For each component, the word "install" always means the following:

1. Pick the correct value to start with.
2. Insert the component into the correct printed circuit board (PCB) location.
3. Orient the component correctly – especially when there is a right and a wrong way to solder it in. (i.e. Electrolytic capacitors, diodes, ICs, transistors, etc…)
4. Solder all connections unless directed otherwise. Ensure enough heat is used to allow solder to flow for clean, shiny, and completed connections.

Also, please be sure to take us seriously when we say that good soldering is the key to the proper operation of your circuit!

- Use a 25W soldering pencil with a clean, sharp tip. DO NOT USE a high power soldering gun such as those trigger activated units.
- Use only rosin core solder intended for electronics use
- Ensure your work area is clean, and has plenty of bright lighting
- Build your kit in stages, taking breaks to check your work. Be sure to clean the board periodically with a brush or compressed air to remove any excess wire cuttings, etc…

Okay, so lets begin!

❒ 1. Our first step in assembling the board will be to install each of the fourteen (14) spark gaps, SG1 through SG14. To begin, use the included fine grit sandpaper, and sand one edge of each of the (28) brass acorn nuts. This edge must be clean of any oxidation or dirt for solder to properly flow and adhere to it. Do this for each acorn nut.

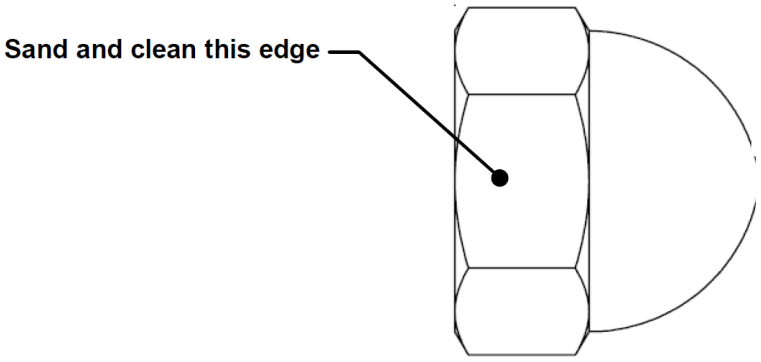


Figure – Sanding location on acorn nut

❒ 2. The next step is to solder each of the brass nuts to the solder pads as shown in the image below. Using the table below to determine the spacing required for the desire spark gap voltage break-down setpoint and use a feeler gauge (not included) or shim stock (not included) to set the proper gap distance.

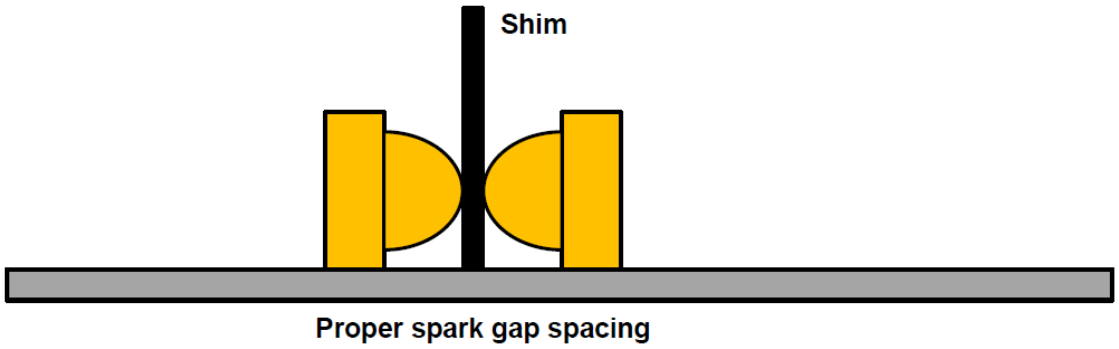


Figure – Spark gap spacing using feeler gauge or shim (not included)

Use a feeler gauge to properly set the spark gap distance to 0.065 inches apart which will set the spark gaps with a firing voltage of approximately 6kV at sea level. If you wish to set the spark gap firing voltage for a value less than 6kV, please use the table below as a reference.

Spark Gap Firing Voltage	Spark Gap Distance (Sea level)
1kV	Contact EVR for more information
2kV	Contact EVR for more information
3kV	Contact EVR for more information
4kV	Contact EVR for more information
5kV	Contact EVR for more information
6kV	0.065” (use feeler gauge)

IMPORTANT NOTE – SPARK GAP FIRING VOLTAGE

Please note that the spark gap firing voltage will vary depending on atmospheric conditions such as temperature, humidity, and air pressure (altitude.) The values and shim provided with the kit are based on average atmospheric conditions at sea level. If you are located at a higher altitude, the spark gap spacings will be considerably different. The best way to test for the proper spacing is to do a single spark gap test. Connect your input DC voltage to the Marx Generator board with only a single spark gap installed (no other components installed) and vary the the spark gap spacing until the spark gap fires just at your maximum input DC voltage that you plan on using with the Marx Generator 2.0.

Once you have determined the approximate position of each of the two (2) spark gaps, solder one acorn nut to the pad in the approximate location you determined previously using your feeler gauge. You will need to use a soldering iron with a large tip and one that has a lot of output power as the nut needs to be heated up for the solder to flow properly. Once the first acorn nut has been installed in place, position the second acorn nut, using the feeler gauge again to properly set the spacing, and solder that to the remaining pad. Once the solder has hardened, check the spacing again with the feeler gauge and if needed, reheat the acorn nut and reposition if necessary.

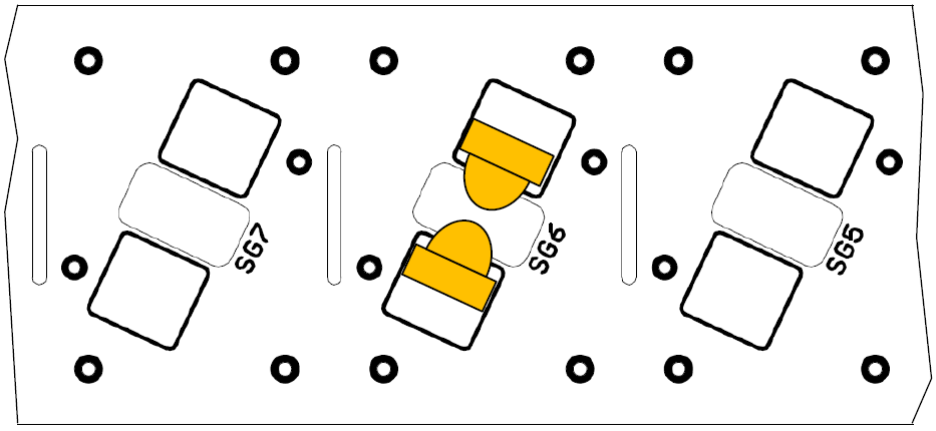
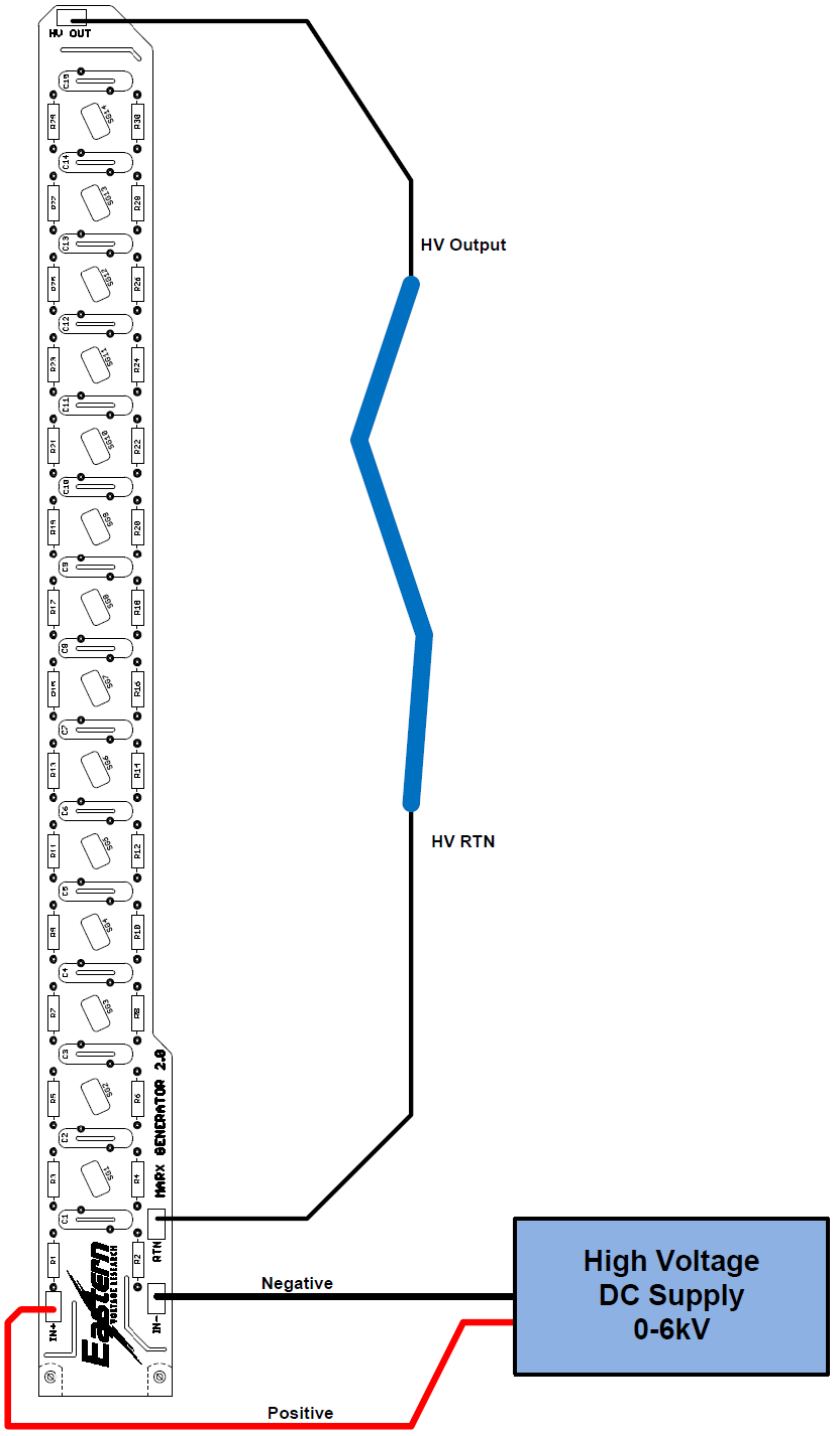


Figure – Single spark gap installed

Repeat this procedure for each of the fourteen (14) spark gaps.

- ❒ 2. Install R1-R30, 1MEG resistor (brown-black-green)
- ❒ 3. Install C1-C15, 0.01uF, 6kV ceramic capacitor
- ❒ 4. Install the two (2) mounting brackets to the base of the PCB board using the provided 6-32 hardware.


HV OUT
HV Output
HV RTN
MARX GENERATOR 2.0
RTN
IN+
IN-
Negative
Positive
High Voltage
DC Supply
0-6kV

Conclusion

We sincerely hope that you have enjoyed the construction of this Eastern Voltage Research Kit. As always, we have tried to write this instruction manual in the easiest, most "user friendly" format that is possible. As our customers, we value your opinions, comments, and additions that you would like to see in future publications. Please submit comments or ideas to:

Eastern Voltage Research, LLC

Technical Support
support@easternvoltageresearch.com

Thanks again from the people here at Eastern Voltage Research.

Terms and Conditions of Sale

Before opening or assemblying your kit, please read and review the latest Terms and Conditions of Sale on our website at the following link:

http://www.easternvoltageresearch.com/terms.html