Instruction Manual

For Type "E" Plasma Tube Electrodes

For the Cheb SSQ-PT, SSQ-ST, SSQ-BAT
and 2" "Original Super Tube" Plasma Tubes
With External Electrodes

(With or without attached wire leads)

Type E1 electrode for SSQ-PT plasma tube.

Manual v1.2 – 12 March 2017

PLEASE READ THIS INFORMATION BEFORE UNPACKING YOUR NEW ELECTRODES

Handling Your Type "E" Electrodes

The special high emissivity coating applied to these electrodes adheres reasonably well to the electrode surface. However, a hard object will scrape the coating off the surface of the electrode. For this reason, please be careful not to hit the electrode with any tools or sharp objects while you are installing or using it.

Keep Them Clean

It is also important to keep the surface of the electrode free from any contamination such as dust, dirt, or oil from your fingers. The electrode may be cleaned with a damp cloth or paper towel. The cleaning rag may be moistened with water or Naphtha, which is commonly sold as lighter fluid. Gentle pressure while cleaning the electrode is okay, but please do not scrub the surface of the electrode with great vigor, or for a long period of time, or you may damage the coating. In general, the less cleaning, the better.

Installing the Electrodes on Your Tube

Please refer to Figure 1 at the back of this document for the correct placement of the Type "E" Electrodes on your Cheb Plasma Tube.

When the electrodes are installed on your plasma tube, the clamping screw should be tightened only sufficiently to prevent the electrode from sliding freely on the tube.

IF YOU MUST USE A LOT OF FORCE TO MOVE THE ELECTRODE ON THE TUBE, THEN IT IS CLAMPED TOO TIGHTLY.

Do not tighten the clamping screw enough to squeeze both sides of the electrode together or the tube may be damaged during operation.

There should be approximately 5 to 8 mm of gap between the two sides of the electrodes after they are clamped on the tube. The exact size of the gap will vary slightly between different electrodes.

Please note that the "E" series electrodes are furnished in pairs, a pair being one left-handed electrode, and one right-hand electrode. The electrodes should be installed on the plasma tube so that the wires leave the electrodes from the side of the electrode that is nearest to the center of the tube.

Special Caution during Use!

Remember that the Type "E" electrodes, just as with any other external electrode, will become quite hot when in operation. They will be both hot in terms of temperature, and "hot" with high voltage radio frequency energy when the tube is in operation.

Because the high emissivity coating on the electrode is electrically conductive, do not allow any conductive object (including your fingers!) to accidentally come in contact with the electrode when the tube is in operation.

Should an accidental contact happen, the resulting small radio frequency electric spark from the electrode to your finger (or whatever contacts the electrode) will burn the coating off of the surface of the electrode at the point where the spark occurs.

Should this happen, do not be alarmed. Minor scratches, scrapes, burn marks, and blemishes in the surface of the coating will not adversely effect the heat radiation from the electrode unless the damage to the surface of the electrode covers more than about 15% of the area of the electrode.

When the tube is in operation, both the tube and the electrodes will get hot. This causes both the plasma tube and the electrodes to expand by a very small amount. When the coating on the electrodes becomes hot, it will soften and stick to the wall of the plasma tube. When the tube is turned off, both the tube and the electrodes start to cool down to room temperature. As the electrodes cool, they shrink at a slightly different rate than the glass wall of the plasma tube.

During the cooling down the process, the electrode coating will suddenly break free from the glass wall of the plasma tube, resulting in a very sharp, loud *"Click!"* sound. The first time you hear this, it can be quite startling. However, don't be alarmed, this is perfectly normal, and may occur several times as the tube cools down.

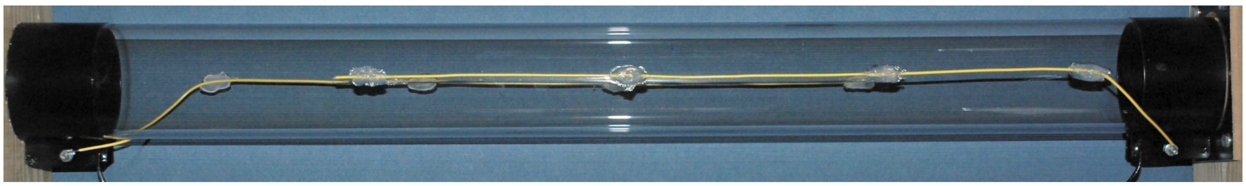
NOTICE! - IF YOU ARE USING AN SSQ-BAT PLASMA TUBE:

If you are using an SSQ-BAT, the following modification is strongly suggested to help prevent possible amplifier damage.

This change in electrode configuration helps to protect the PA1, PA2, PA3, or SPA4 amplifier from excessive tank circuit voltage that is generated when the amplifier is producing RF output power but the plasma tube has failed to light immediately. This may happen when using high modulation frequencies or when the duty cycle is short. A short duty cycle may be caused by a combination of simultaneously running modulation frequencies that combine to produce very short output pulses. When this happens, the plasma tube may fail to light during part or all of the RF output pulse from the amplifier. This failure to of the tube to light may cause amplifier failure, with the destruction of the STW20NK50Z MOSFET in the amplifier.

The reason for this failure to light immediately is due to the lack of ionized gas present when the tube is not turned on. Because it requires some milliseconds for all of the ionized gas to in the tube recombine after the power to the tube is turned off, the tube will normally light properly once it has gone into conduction, as long as the OFF time is substantially less than the ion recombination time. However, when the tube is first turned on, or if the OFF time between modulation pulses is long enough, the number of available ions in the tube will have fallen so low that the tube becomes non-conducting. As a result, it will require a much greater applied RF voltage across the tube electrodes to light the tube for the first modulation pulse than it will for subsequent pulses.

Should a series of very short pulses be applied to the tube when it has not been conducting previously, it is quite possible that the tube may fail to light at all during the series of short pulses. This failure to light will create very high voltages across the amplifier, and may cause MOSFET failure. These failures can be extremely difficult to trace, since they tend be intermittent and random. A system that has been functioning perfectly for an extended period of time may suddenly experience one or more MOSFET failures within a short interval. The addition of the side electrode wires as described here will virtually eliminate this problem.



SSQ-BAT with side electrode wires permanently mounted in place using Silicone adhesive.

The wires should be insulated. Teflon insulation is ideal from the standpoint of heat resistance, but any type of heat resistant insulation is OK. Bare wires should not be used because the RF voltage on the wires may become high enough where the wires touch the tube to cause localized overheating of the tube wall. This may cause the glass to crack at that point, ruining the tube. The insulation on the wire will space the wire far enough from the tube wall to reduce the electrical and heat stress enough to prevent tube damage. The wire used here is AWG 22, but any wire from AWG 24 to AWG 10 should work as well.

The wires should run on opposite sides of the tube, directly across from each other. It does not matter where they are placed, side, top, bottom, or wherever, just place them across the tube from each other. The wires should extend about three-quarters of the distance from one electrode to the other electrode.

For these photos, the wire was held in place with plastic tape. If you have tape which will tolerate 100° C temperature without melting or loosening, then using tape will work OK. On my tube, I used Silicone seal adhesive, which will withstand high temperatures. I used several strips of tape to hold the wires in place against the tube, and then applied four blobs of the adhesive to hold the wire against the tube. The tape was removed 24 hours later after the adhesive had hardened. Do NOT use an adhesive which is not flexible when it has hardened. A non-flexible adhesive can cause the glass of the tube wall to crack due to stress when it gets hot. This may result in a shattered tube.

Please refer to the web article at:

http://rife-beam-ray.com/SSQ-BAT_wires.htm

for additional information.

WHY ARE TYPE “E” ELECTRODES BETTER THAN ORDINARY METAL ELECTRODES?

Please note that while using a type “E” electrode on your Cheb plasma tube will greatly reduce the chance of thermal damage to your tube, using the type “E” electrodes does not guarantee that the tube will never fail.

Excessive heat is the most common cause of Plasma tube failure. This type of damage will typically result in contamination of the gas mixture inside the tube, causing an unwanted color shift in the discharge and/or poor performance.

The Cheb 1” x 14” SSQ-PT plasma tubes and other straight plasma tubes such as the Cheb 2” Super Tube use external wrap-around (“collar”) electrodes. When external electrodes are excited by radio frequency energy, they cause the gas inside the tube to ionize and glow. The process of ionizing the gas causes the glass wall of the tube directly under the electrodes to become very hot.

Using ordinary bare copper or aluminum electrodes may result in damage to the tube wall due to overheating if high powers are used or if the electrode is too small for the power level being used. Thermal damage occurs because untreated copper or aluminum electrodes do not effectively radiate the heat away from the electrode.

The wall of the plasma tube is cooled by three mechanisms, conduction, convection, and radiation.

Conduction cooling occurs when heat is transferred from one object to another when two objects are in direct, intimate contact with each other. (Such as when you put your finger on a hot stove.)

Convection cooling is cooling by the room air that surrounds the tube. As the hot tube heats the air in contact with the tube wall, the hot air rises away from the tube and is replaced by cooler air.

Radiation cooling is when the glass surface of the tube becomes hot enough to radiate away some of the heat as infrared energy. Radiation cooling can account for as much as 50% of the heat that is dissipated by the plasma tube. (Such as when you stand in front of an open fire.)

Unfortunately, that part of the tube wall that is covered by the external electrode cannot dissipate any heat by convection. The only way that area of the tube wall may be cooled is by conduction of heat into the electrode which is then radiated away by the electrode.

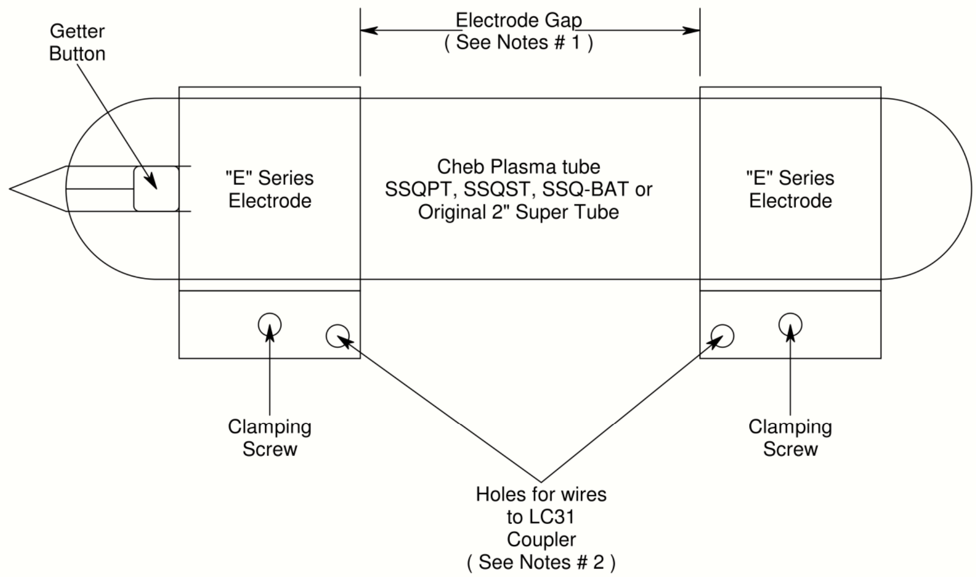
Emissivity is a measure of how well an object can radiate or absorb heat. An object which radiates heat with 100% efficiency will have an emissivity rating of 1.0 or (100%). An object which cannot radiate any heat at all will have an emissivity rating of 0.0 or (0%).

Ordinary shiny aluminum is a very poor choice for electrodes because it has an emissivity of approximately 0.05 (5%.) Copper is somewhat better, with emissivity values ranging from 0.02 to 0.4 (2% to 40) depending upon the surface condition of the copper. Even so, from this it is apparent that a better electrode material is needed. This is even more important if the tube is operated at a high average power level.

What is needed to keep the tube cool is electrode that can absorb the heat energy that is radiated by the glass wall of the tube under the electrode and then in turn dissipate that heat by a combination of convection cooling and radiation cooling.

Spectrotek electrodes are coated with a high quality carbon bearing material. This process allows us to manufacture external copper electrodes that have an emissivity value close to 0.98. These electrodes work so well at dissipating heat that once the power to the tube is turned off after an extended run time, the electrodes and the tube area under the electrodes will actually cool off faster than the rest of the tube.

Type "E" Electrode Placement on Cheb Plasma Tubes
Spectrotek Services
30 June 2014



NOTES: (Drawing not to scale.)

1 - Gap length for 25 mm SSQ-PT = 232 mm
Gap length for 48 mm SSQ-ST = 333 mm
Gap length for 76 mm 3" SSQ-BAT = 660 mm
Gap length for 50 mm 2" Super Tube = 483 mm

Gap length is not critical. Adjust to fit your tube mounting arrangement.

2 - Wire length for 25 mm SSQ-PT = 216 mm each wire
Wire length for 48 mm SSQ-ST = 303 mm each wire
Wire length for 76 mm SSQ-BAT = 303 mm each wire
Wire length for 50 mm 2" Super Tube = 305 mm each wire

Wire lengths may vary by -5% or +10% with little change in performance.

(See LC31S/P Instruction Manual for additional information.)

Figure 1