

*SHQ400 SERIES  
SUBSTRATE HEATER*

**INSTALLATION  
MANUAL**

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**NOTE:** Information and data in this manual are subject to periodic amendments, revisions and additions. Please consult factory for the most current information and revision.



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### IMPORTANT

SOME INFORMATION IN THIS MANUAL MAY APPLY TO OPTIONS THAT ARE NOT SPECIFIC TO YOUR HEATER ASSEMBLY. PLEASE CONTACT AJA DIRECTLY WITH ANY QUESTIONS YOU MAY HAVE.

ROTATION, BIASING, Z MOTION AND COIL HEATERS ARE NOT COVERED IN THIS MANUAL AT THIS TIME.

However, some general precautions are:

ROTATION should always be ON when heating and or biasing the substrate holder plate. The rotation should not exceed 20 rpm.

RF or DC BIASING power should never exceed 50 watts.

## SECTION 1 – WARNINGS !!

### WARNINGS !!

**FAILURE TO PROPERLY INSTALL OR OPERATE THIS PRODUCT CAN RESULT IN PRODUCT DAMAGE, RF INTERFERENCE, ELECTROCUTION, BURNS, EYE INJURY OR DEATH. PLEASE EXERCISE EXTREME CAUTION IN OPERATION OR MODIFICATION OF THIS EQUIPMENT AND BE CERTAIN ALL PERSONNEL COMING INTO CONTACT WITH THE EQUIPMENT ARE AWARE OF THE FOLLOWING HAZARDS:**

**HIGH VOLTAGE:** THIS PRODUCT REQUIRES CONNECTION TO A 220 VAC SOURCE. IT IS ABSOLUTELY ESSENTIAL THAT THE VACUUM CHAMBER AND ALL PARTS OF THE SUBSTRATE HEATER ASSEMBLY ARE PROPERLY GROUNDED AND AT THE SAME POTENTIAL.

Make sure all power to your Heater Controller is shut off and is disconnected before any work is performed on the substrate heater.

**COOLING WATER:** THE QUARTZ HALOGEN BULBS GENERATE SUBSTANTIAL HEATING. OPERATING THE HEATER WITHOUT THE MINIMUM COOLING WATER FLOW (0.8 GPM@ 50-60PSI, 10-25 C ) COULD RESULT IN SEVERE DAMAGE THE ALUMINUM HEATER BLOCK ASSEMBLY. THE USE OF A COOLING FLOW INTERLOCK DEVICE IS HIGHLY RECOMMENDED. IN LOCATIONS WHERE COOLING WATER LINES EXHIBIT SIGNIFIGANT MINERAL DEPOSITS (WHICH WILL EVENTUALLY CLOG COOLING LINES), A FILTER OR CLOSED LOOP CHILLER IS RECOMMENDED. CONDENSATION AROUND COOLING LINES SHOULD BE AVOIDED. THEREFORE, THE COOLING TEMPERATURE MUST BE KEPT ABOVE THE POINT WITHIN THE OPERATING RANGE THAT AVOIDS CONDENSATION.

**HOT!:** SUBSTRATE HOLDERS UNDER VACUUM CAN REMAIN HOT FOR A VERY LONG TIME. ALLOW THE HOLDER TO COOL BEFORE HANDLING.

**RETURN OF CONTAMINATED EQUIPMENT:** NEVER SHIP OR RETURN A SUBSTRATE HEATER ASSEMBLY CONTAMINATED WITH HAZARDOUS MATERIALS TO AJA INTERNATIONAL. ALL RETURNS REQUIRE FULL DISCLOSURE OF MATERIALS USED AND THE POTENTIAL HEALTH RISKS THEREOF, PRIOR TO THE ISSUANCE OF A RETURN AUTHORIZATION NUMBER.

## SECTION 2 - UNPACKING

### A. OPENING PACKAGE

1. Carefully unpack the SHQ400 Series Substrate Heater and compare contents to the packing list. If a discrepancy exists between what was ordered, the packing list or what has been shipped, contact AJA International immediately.

**NOTE:** The in-vacuum parts of the heater assembly have been pre-cleaned at the AJA factory. It is recommended you use clean rubber or nylon gloves to handle these parts. Fingerprints on the quartz bulbs can significantly reduce their life.

### B. EXAMINE CONTENTS

2. Place the substrate heater assembly and any ancillary components ordered on an appropriately clean work surface and familiarize yourself with the basic parts of the heater system.

**NOTE:** Check that the quartz lamps and main temperature thermocouple are fully seated and that their set screws have not become loose during shipment. These should be firmly snug to heat-sink the lamp base to the water cooled aluminum reflector block, but **DO NOT** over-tighten.

**NOTE:** On heater blocks with a substrate gas ring there is no direct access to the set screws of the lamps without first removing the gas ring assembly. Check the lamps first by moving their bases where the electrical pins protrude out of the heater block. If they are firmly in place and there is no movement then tightening their set screws is not needed at this time.

### C. TOOLS

1. 5/64" hex key wrench – quartz lamp and MAIN thermocouple. 1/16" hex key wrench – OT thermocouple.

## SECTION 3 - INSTALLATION

### WARNING !!

THE CABLES DESIGNED TO OPERATE THE LAMPS MAY OR MAY NOT CARRY EARTH GROUND INTO THE VACUUM SIDE OF THE FEEDTHROUGH. It is absolutely essential that the vacuum chamber and all parts of the substrate heater assembly be properly grounded and at the same potential before operating the substrate heater.

### WARNING !!

Accidental sputtering or coating of the quartz plate, quartz bulbs, or inside the reflector area of the heater block can significantly affect the operation the heater. Localized overheating of the lamps can occur and may result in the inability of the Heater Controller to maintain a constant temperature, will lower the heater output and can reduce the life of the quartz lamps.

NOTE: Your heater assembly may require a procedure other than that described in this section. Contact AJA for specific information regarding your heater assembly.

### A. HEATER BLOCK INSTALLATION AND MOUNTING

1. Make sure all power to your Heater Controller is shut off and is disconnected before any work is performed on the substrate heater.
2. If you are using your own substrate holder, it should be designed to completely cover the quartz plate and reflector area of the heater block.
3. In some cases your heater block assembly will be part of a custom flange that was designed to your specifications. This flange usually has all the feedthrough ( power, TC's(thermocouples), and water) necessary to operate the heater already on it. The heater block assembly will already be attached and will be connected to the vacuum side of these feedthroughs. This custom flange can be attached directly to your chamber. Contact AJA if you have questions regarding mounting.
4. However, in some cases the removal of the heater block assembly from the custom flange will be necessary to facilitate mounting the custom flange to your chamber. If this is the case, then make all disconnects at the heater block assembly. This would include the white TC connector(s) the larger white ceramic lamp connectors, and the VCR cooling water connections.
  - a. Then, loosen the clamp which holds the heater block on to the feedthrough tube. Carefully remove the heater block by sliding it off of the end of the tube. Installation is the reverse. Be sure to reconnect the MAIN TC1 correctly. And also(only if applicable), connect the HIGHTEMP TC2 thermocouple correctly. Be sure to reconnect the lamps correctly. ( See Electrical Connections, C. and D. )

### IMPORTANT:

After reinstalling the heater block on to the feedthrough tube be sure to check the distance between the substrate holder plate and the bottom of the heater block. This distance should be 2 - 3mm maximum when the substrate holder plate is fully positioned on to the substrate holder rod. Keeping this gap close allows more heat to be absorbed by the substrate holder and also prevents deposited material from getting on to the quartz plate. However, the plate must not touch the heater block while it is rotating. To adjust the gap loosen the heater block clamp and slide the block slightly to make the correct gap.

5. If your heater block assembly is not part of a custom flange with feedthroughs, then careful consideration should be given to the mounting and location of the heater block within your chamber. The utilities connections should be as accessible as possible and must meet the heater's electrical and cooling requirements Your mounting must not interfere with the heaters operation. Keep in mind that the removal of the bottom plate that holds the quartz plate is necessary for replacement of the quartz lamps. Vacuum compatible components (vented screws, etc.) should be used. Contact AJA with specific questions regarding mounting of the heater assembly.

## SECTION 3 – INSTALLATION cont.

### B. COOLING WATER CONNECTION

#### WARNING !!

Significant damage to the heater block can occur without proper cooling when operating the SHQ400. Minimum cooling flow should be 0.8 GPM minimum @ 10-25 C. Cooling MUST be maintained to protect the aluminum heater block.

**NOTE:** Certain models use o-ring seals between the aluminum heater block and the S/S cooling plate. Be sure the screws that attach the heater block to this plate are tightened properly to prevent cooling water leakage. On other models a copper mesh material is used between the heater block and a sealed S/S cooling plate to enhance thermal transfer. These screws must also be tight. The above models use an additional thermocouple to measure the temperature of the aluminum block. This is the Overtemp TC and will need to be connected on these models only. On most newer models the aluminum heater block is bonded directly to the S/S cooling plate. Therefore, no overtemp TC is needed. The S/S cooling plate mounting screws are still there as part of the bonding process and should be left in place.

#### 1. VACUUM SIDE

- a. There are two 1/4" male VCR fittings located on the S/S cooling plate that is bolted or bonded to the aluminum heater block. The two S/S tubes with female VCR fittings, which come from the flange assembly, are connected to this cooling plate. In most cases these tubes have flexible tube extensions welded to them. Be sure not to significantly twist these when making the connections. Cooling can flow in either direction. Follow standard VCR procedures for making these connections. Silver plated Ni gaskets are recommended.

**NOTE:** Some AJA heaters may have swagelok type fittings, therefore, the back ferrules of any swagelok type fitting used in vacuum should be grooved to help eliminate virtual leaks around the tubing ferrules.

#### 2. ATMOSPHERE SIDE

- a. connections are generally 1/4" Swagelok and may include push-on type fittings to make a quick connection. Teflon tubing is recommended for this connection. If you are connecting directly to the swage fittings be sure to pre-swage any fittings before attaching them to these connections. Do not put undue stress on the fittings when tightening them. Cooling can flow in either direction.

### C. ELECTRICAL CONNECTIONS AND THE QUARTZ LAMPS.

#### WARNING !!

THE CABLES DESIGNED TO OPERATE THE LAMPS MAY OR MAY NOT CARRY EARTH GROUND INTO THE VACUUM SIDE OF THE FEEDTHROUGH. It is absolutely essential that the vacuum chamber and all parts of the substrate heater assembly be properly grounded and at the same potential before operating the substrate heater.

1. Make sure all power to your Heater Controller is shut off and is disconnected before any work is performed on the substrate heater.
2. Vacuum Side
  - a. The white, rectangular ceramic connector(s), without markings, are used to connect the quartz lamp(s) in vacuum. There are two Teflon covered leads to each connector. The connector is not orientation specific and may be connected to either lamp.

## SECTION 3 – INSTALLATION cont.

### C. ELECTRICAL CONNECTIONS AND THE QUARTZ LAMPS, cont.

**NOTE:** Removal of these connectors may be necessary to mount the assembly on to your chamber. Slide the connectors off the lamps base pins to remove. (do not disassemble the connectors unless it is necessary (see below)). To connect them: Push them on to fully cover the two round pins at the lamp base. If the lamp pins are not fully covered a plasma may form with the process gas and can quickly damage the lamp-base/heater assembly. UHV aluminum foil or a foil that is compatible with your process should be used to cover the lamp and TC connectors to help reduce the accumulation of deposited materials on these connectors.

### **WARNING !!**

**BE SURE TO CHECK THE HEATER CONTROLLER SCHEMATICS IF IT IS NECESSARY TO DISASSEMBLE THE LAMP CONNECTORS TO INSTALL THE HEATER INTO YOUR CHAMBER.**

3. **NOTE ON CERTAIN MODELS:** Any ceramic beads covering the lamp lead wire, and or Teflon tubing covering the power feedthrough pin wires, are there for safety and to prevent a plasma forming around an exposed connector or wire. Upon installation check that any ceramic beads and or Teflon tubing fully cover any exposed areas.
4. **Atmosphere Side:**
  - a. The gray custom cable or black SJ type cable with the silver colored Amphenol round electrical connector on one end is used to connect the atmosphere side of the lamp(s) feedthrough to the AJA Heater Controller. It is "keyed" and can only fit one way into the vacuum electrical feedthrough. Be sure it is fully threaded onto the feedthrough connector. Strain relief support of this cable is strongly recommended.
5. **IMPORTANT: THE CABLES DESIGNED TO OPERATE THE LAMPS MAY OR MAY NOT CARRY EARTH GROUND INTO THE VACUUM SIDE OF THE FEEDTHROUGH.**
  - a. In most cases the ground is not carried beyond the vacuum feedthrough. If your heater box is to be mounted independently of a heater assembly flange then be sure that a separate ground wire is run to a proper ground location within your chamber.

### D. ELECTRICAL CONNECTIONS, THERMOCOUPLES ( TC's ).

### **WARNING!!**

**BE SURE THAT THE MAIN AND HIGHTEMP T/C CONNECTIONS ARE MADE PROPERLY BEFORE OPERATING THE HEATER.**

1. There can be two "K" type TC's that maintain and monitor temperature within the heater block assembly. The smaller white ceramic connectors with polarity markings are used for both TCs. Both the thermocouple shafts are held in place by set-screws.
2. The MAIN TC is mounted at an angle from the back of the heater block. It protrudes into the reflector area of the heater block and has two beveled sleeves covering it. The inner sleeve is ceramic and over it is an inconel sleeve. When this T/C is mounted properly, the tip should just touch the quartz plate that covers the lamps and reflector area of the heater block and the sleeves are held in place by the quartz plate. The setscrew should be just tight enough to hold the T/C in place.

**NOTE:** If your heater is different than described above then refer to any schematics shipped with the heater or contact AJA for specific information.

## SECTION 3 – INSTALLATION cont.

### D. ELECTRICAL CONNECTIONS, THERMOCOUPLES ( TC's ). Cont.

**NOTE:** The HIGHTEMP(overtemp)TC is NOT applicable to heaters with a bonded S/S cooling plate. The HIGHTEMP or (overtemp) TC is placed into the non-threaded hole located at the back end of the heater block. It usually has a bend in the shaft. It should be inserted just enough so the tip touches the bottom of the hole. The setscrew should be just tight enough to hold the T/C in place. The HIGHTEMP T/C monitors the temperature of the aluminum heater block itself. When a high-temp condition occurs power to the lamps will be shut off.

IF THIS CONDITION OCCURS BE SURE TO CHECK FOR PROPER COOLING FLOW BEFORE OPERATING THE HEATER AGAIN. Also check that the screws that hold the S/S cooling plate to the aluminum block are tight.

#### **IMPORTANT:**

The HIGHTEMP on the AJA SHQ2000 controller has been preset to a temperature that is correct for your heater assembly. In general, the overtemp should not exceed 300 – 350 °C. Contact AJA with any questions regarding changes to the OVERTEMP setting.

3. The yellow coiled TC wire with yellow connectors is used to connect the AJA Heater Controller to the atmosphere side of the TC feedthrough. The smaller female connectors attach to the feedthrough. The larger male connectors attach at the back of the AJA Heater Controller.

**NOTE:** These connectors are orientation specific. Strain relief/support of this cable is recommended.

#### **WARNING !!**

BE SURE THAT THE MAIN AND, IF APPLICABLE, HIGHTEMP TC CONNECTIONS ARE MADE PROPERLY BEFORE OPERATING THE HEATER.



## SECTION 4 – QUARTZ LAMP REPLACEMENT

### WARNING !!

SHUT OFF AND DISCONNECT ALL POWER TO THE SUBSTRATE HEATER BEFORE REPLACING A LAMP. ALLOW LAMPS TO FULLY COOL BEFORE REMOVING.

**HOT !!** SUBSTRATE HOLDERS UNDER VACUUM CAN REMAIN HOT FOR A VERY LONG TIME. ALLOW THE HOLDER TO COOL BEFORE HANDLING.

**CAUTION!!** FINGER PRINTS ON THE QUARTZ LAMPS CAN SIGNIFICANTLY REDUCE THEIR LIFE. USE CLEAN RUBBER OR NYLON GLOVES TO HANDLE THE NEW LAMPS.

#### A. ACCESSING THE QUARTZ LAMPS

1. The quartz glass cover plate must be removed.
2. **Heater with propeller type substrate holder:**
  - a. Remove the small propeller attachment that is attached to the end of the substrate rotation rod by removing the three 4-40 X ¼" screws that hold the propeller to the rod.
  - b. New screws are recommended when reattaching the propeller. The screws are made of 18-8 S/S.
  - c. The propeller attachment should be concentric to the end of the rotation rod when installed correctly.
3. **Other types:** Contact AJA.
4. After removing the propeller attachment:
  - a. Remove the # 8-32 screws that hold the inconel bottom plate (or bottom plate/gas ring assembly) to the aluminum heater block.
  - b. Carefully pull the bottom plate and quartz glass plate away from the heater block. The quartz plate has a small step along its circumference. The quartz plate is captured loosely by the corresponding step in the inconel bottom plate. This is to allow for expansion.
  - c. The Main T/C tip should have been just touching the quartz plate.
  - d. Make note that the two bevel-cut sleeves (the inner one is ceramic and the outer one is inconel) that cover the MAIN thermocouple, are held in place by the quartz plate. Be sure the sleeves are back in place when reassembling the heater block. These sleeves can present a challenge to reinstall when the heater assembly faces down. It is suggested that you use a thin 6" S/S ruler to hold the sleeves in place while someone else puts the quartz plate back in position.
5. Remove the white rectangular ceramic connector from the base of the lamp by carefully sliding it off the lamp pins.
  - a. Then use a 5/64" hex key wrench to loosen the set screw that holds the base of the lamp and slide the lamp out of its mounting hole. It is recommended to replace all lamps with new ones at the same time.

**NOTE:** Other AJA heater boxes may be different than described above. The T/C arrangement may be different. Also there may be no quartz plate and it may require the removal of an end or side plate to gain access to the lamp(s). Be careful not to bend or damage any thermal copper mesh that may have been used under this plate. Replacing with new mesh is recommended. Contact AJA for information specific to your heater assembly.

### IMPORTANT !!

BE SURE TO CHECK THE HEATER CONTROLLER ELECTRICAL SCHEMATICS FOR THE CORRECT LAMP VOLTAGE AND WATTAGE FOR YOUR HEATER.

## SECTION 4 – QUARTZ LAMP REPLACEMENT, cont.

6. Installation is the reverse. Be sure the new lamp is pushed firmly into its mounting base. Then, the setscrew should be firmly snug to heat-sink the lamp base to the aluminum heater block, but do not over tighten. Be aware that base of the replacement lamp must be made of aluminum. Some after-market lamps have ceramic bases. Do not use ceramic base lamps. These can cause damage to the heater assembly.
7. The lamp connectors should be pushed on to fully cover the two round pins at the lamp base. If the lamp pins are not fully covered a plasma may form with the process gas and can quickly damage the lamp and heater assembly.

**NOTE:** It is important that conductive deposited material be kept away from the lamp connectors. Use shielding such as UHV aluminum foil to keep the deposited material from accumulating on the lamp connectors.