

9600 X-Ray Gun Controller

Configuration for Surface Science Instruments Spot or Line/Spot Guns

Overview of 9600 Supply

The 9600 series X-Ray Gun controllers provide control of the Glassman ER or WG High Voltage Power supplies, filament current, 2.3 KV electron beam cathode heating and beam spot size. The output beam current is fully regulated for improved stability of the X-Ray beam. There is a service mode which allows unattended outgasing of the filament, cathode and high voltage conditioning of the gun after major servicing. All adjustments are at ground potential and easily accessible. Finally, the M&W water cooling system is controlled from the X-Ray Gun Controller to extend the life of the circulating pump.

Overview of Power Supply Installation

There are three parts to the installation of the 9600 Power supply.

1. Physical installation of the controller
2. Connecting to existing interlock system.
3. Install interface card on the back of the Glassman Power supply.
4. Modifying the M&W so it can be controlled from the 9600 Controller.
5. Install the Computer interface.
6. Check out operation of Gun Controller.

Before operation of the 9600 Controller the Glassman HV supply must be connected, the Glassman control interface installed, the Glassman turned on and the HV enabled.

The M&W interface must be installed before the Controller is switched to the OPERATE mode.

Physical installation of the X-ray controller

After removing the 9600 Controller from the shipping container remove the top cover. Remove the plastic HV cover at the left rear of the box. Remove all polypro foam use to avoid vibration of the cards. Inspect the cables to see that none have come loose in shipping. Re-install plastic HV cover.

The switch to select the Model of Glassman needs to be set. The back position is used to selects WG and forward position to select ER Glassman models. See figure. 1.

Replace top cover but do not replace retaining screws.

Install the Model 9603 X-Ray Gun Controller right below the Glassman High Voltage power supply. This may require relocating the Glassman supply. The Model 9603

should be connected to the Sola Power Conditioner that was used with the old 8702 controller.

Connect to existing interlock system

1. Splice the interlock cable into the 24 volt system interlock. The interlock cable, supplied in the installation kit, has the 2 conductor cable attached to the 4-pin circular connector. The other end has no connector.
 - a. Locate the system 24 volt interlock cable that was attached to the "System Interlock In" connector (J3) of the Model 8702. Follow this cable back to Power Module where it is attached to J17. Disconnect the cable from J17 so the power from the power module is removed. Cut this cable into two parts. Make the cut about 8 inches from the MODEL 8702 end of the cable. The long piece is the new "interlock feed" cable. Strip the cable jacket back about 4 inches. The short piece will be use to supply a spare interlock outlet.
 - b. Remove the cable connected to the "System Interlock Out" connector (J5) on the back of the Model 8702. Cut the connector off the end of the "System Interlock Out" cables. These cables will be spliced to the "interlock feed" cable in a later step.
 - c. On the "Interlock feed" cable, the "System Interlock Out" cables and the 8" piece of cable remove about 1/4 inch of the insulation from all exposed wires.
 - d. Now determine the polarity of the DC Voltage in the "interlock feed cable". Re-connect the "interlock feed" cable to J17 on the Power Module. Use a voltmeter set to DC Volts to determine the positive lead of this cable. Measure between the two wires in the cable, the ground is floating. Remove the shell from the new interlock cable circular connector and verify the color of the wire that is connected to pin 1. Place the wire connected to pin 1 of the new cable and the (+) lead in the "System Interlock In" cable together in one end of the inline splice and crimp. Also, connect the (-) side of the two wires in another inline crimp.
 - e. Place one wire from the 8" cable (that was connected to the 8702), one wire from each of the "System Interlock Out" cables into the other end of the (+) inline connector and crimp. Be sure to match the colors so the wires in both ends of the splice are the same for all the old cables. Connect the remaining negative (-) leads together with the second inline splice. This leaves in place a spare interlock connector for emergency use of the 8702. It also connects the interlock "in" and "out" cables that previously passed through the 8702.

2. Install the High Voltage Shut Down cable into the 24 volt interlock connector. The High Voltage Shut Down cable can be found attached to the back of the Glassman High Voltage power supply. It is attached to terminals 2 and 3 on the terminal block. A ceramic capacitor is connected between the

leads. Remove the cable from the Glassman. Cut the lugs and the capacitor from the wires. Crimp new socket terminals onto the wires (these are supplied in a zip lock bag). The socket terminals are female terminals that mate to the circular connector on the back of the 9603 Power supply. Insert the High Voltage Shut Down sockets terminals into the two available holes in the circular interlock connector. There is no need to be match colors to specific pins.

3. The new interlock cable can now be attached to the interlock connector on the back of the 9603 X-Ray Gun controller.

Install interface card on the back of the Glassman Power supply

Install the Glassman interface card to the terminal block on the back of the Glassman. The card can be used with the older WG or newer ER series supplies. The interface supplies the 24 volt interlock signal for the older WG supplies. For the newer ER series the interface eliminates the need to install a 24 volt relay in the supply. The interface enables the 9603 X-Ray Gun controller to slowly ramp the 10KV. A 10 volt full scale signal for monitoring output current is provided to the 9603 X-Ray Gun controller through the interface. To install the interface remove all jumpers except:

- a. TRM 1 – TRM 2
- b. TRM 8 – TRM 9

Loosen the remaining terminal screws. Slide the interface card into place. Be sure the first spade lug is matched to terminal 1. On the WG the last spade lug will not be used. On the ER the last spade lug will connect to terminal 11. Hold the card up so all space lugs are fully engaged and tighten all screws. Connect the cable to the card and to the “Glassman” Connector on the 9603.

If a WG supply is used remove old HV interlock connector from the Glassman and install the small cable supplied in the kit in its place. Connect the red 2 pin connector two pin receptacle on the interface card.

Connect the High Voltage cable from the Glassman to the 9603 X-Ray Gun controller.

Connect the Ground braid from the 9603 X-Ray Gun controller to the ground terminal on the Glassman high voltage supply. This is a very important connection. There is now ground return in the coax HV cable.

Modifying the M&W so it can be controlled from the 9600 Controller

The M&W is turned on when ever HV is turned on to produce x-rays. The M&W is turned off when the 9600 Controller is in Stand-By. This feature is over-ridden by turning the M&W front panel power switch to ON.

1. First install the M&W control relay. Instructions are included with the relay. A new cable is included. The new cable has a connector that replaces the one on the side of the M&W.
2. Connect the new Control cable from the M&W to the M&W circular connector on the back panel of the 9603 X-Ray Gun controller.
3. Remove the M&W water flow cable from J18 on the Power Module. Install the Jumper Connector (supplied in kit) on J18.

Install the Computer interface

On ESCA's with a USB interface upgrade, connect the computer control cable between the 9600 connector on the back of the position computer to the "Computer" connector on the back of the 9603 X-Ray Gun controller. On systems without the USB upgrade an updated "Data Fan-out panel will be required. In this situation separate instruction will be provided.

Initial Startup

NOTE: WE HAVE FOUND THAT THE GUN CAN NOT BE SAFELY OPERATED AT 400X400 MICRONS AND 100 WATTS. THE 400 MICRONS SPOT MUST BE ADJUSTED TO 500 X 500 MICRONS. IF THE POWER IS SET TO 50 WATTS FOR THE 200 MICRONS SPOT THEN THE SPOT SIZE MUST BE INCREASED TO 300 X 300 MICRONS.

BE SURE TO CONNECT THE HAND HELD SPOT CONTROL BOX TO THE X-RAY GUN CONTROLLER USING THE RIBBON CABLE BEFORE TURNING ON THE CONTROLLER. THIS BOX MUST ALWAYS BE CONNECTED

THE FIRST TIME A GUN IS INSTALLED IN A SYSTEM THE START UP PROCEDURE WILL REQUIRE ABOUT 3 DAYS. THIS PERIOD SHOULD NOT BE HURRIED. CONSIDERABLE OUT GASSING WILL BE EXPERIENCED. THE MATERIAL THAT IS VOLATIZED HAS BEEN FOUND TO BE HARMFUL TO THE GUN IF THE OUT GASSING CAUSES HIGH PRESSURES IN THE GUN TUBE. THE CHAMBER PRESSURE IS NOT A GOOD MEASURE OF THE ACTUAL PRESSURE IN THE GUN TUBE.

1. Turn on the 9603 X-Ray gun controller. The Interlock OK LED should come on. If not insure that all necessary interlock conditions are met as indicated on the manual vacuum controller front panel. Turn the Glassman on and press the HV ON button. The 2KV supply is referenced to the output of the Glassman. It is important that the Glassman is on even if its output voltage is at zero to establish a useful reference.

- a. Set the front panel toggle switch labeled "SERVICE" to the SERVICE position. Rotate the INCREASE TIME potentiometer full clockwise.
- b. Pull the box about 6 inches out of the rack and slide the cover back. Note the 6 Red LED that on the vertical board mounted to the inner bulkhead. They are a little left of center at the top. The first column indicates the filament ramp status. The second column indicates the 2KV status and the third column indicates the 10 KV status. The top light in each column indicates that that function is enabled. The lower LED indicates the control loop is regulating on I Fil, I 2KV or V 10 KV. This will become more interesting as we proceed.

Filament Ramp

- c. Press the Start Filament push button. On the front panel the Filament On LED should turn on. If the Sample Transfer is homed and valve #4 is closed then the Xfer OK LED should be on. On the inside board the Two LED in column 1 should be on showing the system is ramping the Filament current.
- d. The front panel meter will default to the I FIL mode. The meter should read about .65Amps.
- e. Move the Service switch to the down position The supply will ramp the filament to 1.38 Amps over about 1 ½ to 2 minutes. At the end of this period the ramp will switch to I 2KV.

I 2KV Ramp

- f. To monitor this change watch the LED's inside the box. When the change in mode is made the top LED in the first column will go out and the top LED in the second Column will turn on. The I 2KV control is enabled but the V 2KV is not high to extract a significant emission current.. To avoid damage to the filament the regulation remains tied to the filament current. This is noted by the Lower LED in the first column is still on.
- g. The 2KV will increase over about 30 second to 2.3 KV. This can be monitored on the front panel meter. At about 1.9 KV the 2KV OK light on the front panel will come turn on. This will enable the control loop to regulate the I 2KV ramp. The bottom LED in the second column will come on.

Stand-By

- h. When the I 2KV ramp completes the auto start process will halt. This halt condition is the state used for Stand-By. The I 2KV will be at about 6 ma. NOTE: This includes about 2.2ma of bias current used for the Pierce circuit. The actual I 2KV is about 4ma in Stand-by. You can return to Stand-by from the operate mode at any time.

Operate

2. When the vacuum has stabilized the high voltage ramp may be started. **Be sure the M&W is safe to operate by turning on the M&W front panel power switch. The Flow OK LED, on the front panel, should come on as soon as the flow stabilizes.** After verifying the flow interlock, turn off the M&W front pane power switch. The 9603 X-Ray Gun controller will turn the M&W back on.
 - a. Turn the Glassman current limit 10- turn pot one (1) turn.
 - b. Select OPERATE on the 9603 X-Ray Gun controller front panel.
 - c. Select the 100 micron Spot size.
 - d. The M&W will turn on. The M&W On LED will indicate this. The Flow OK LED will come on when the flow stablizes.
 - e. The Glassman voltage will jump to about 2.5 KV.

IT IS IMPORTANT TO RAMP THE HIGH VOLTAGE TO 10KV USING THE SERVICE RAMP FOR THE INITIAL TURN ON PROCEDURE. Turn the ramp rate control full ccw. This will provide about a 2-3 hr ramp.

The Glassman voltage will ramp to 10 KV. If the gun has been in service an is well conditioned you can switch the service switch down and let the 10KV ramp quickly to about 5 KV. Then go back to service and check all meter settings. The following values are typical at this point.

- I out 0.5 to 1.2 ma
- I fil 1.40 to 1.44
- V 2Kv 2.3 KV
- I 2KV 5.8 to 6.5 ma
- V Focus 3.8-4.2 KV
- V Quad 0

Next go to about 7KV then return to Service. Hold for about 5 minutes. Then go to about 8KV. Let it ramp in Service mode the rest of the way the first time.

When the Glassman voltage reaches about 9.2KV the 10 KV OK LED and the Spot On LED's will turn on. This indicates that the supply is now actively controlling the gun output current. The I Out should read 1.5ma

If the vacuum system has been opened to atmosphere for gun repair or any other reason the controller should be left in the Service Mode. Manual speedup steps should not be provided. If the gun has had major repairs the full c.w. position of the ramp speed control should be used. After initial conditioning of the gun the SERVICE switch can be in the down position at all times but the ramp rate pot should be in c.w. position for the HV ramp.

Preliminary Checks after 10KV is attained

1. Typical front panel values. The meter reads the major operating parameters. During start up these parameters help provide an indication of how well the gun is cleaning up. After the Glassman reaches 10KV all meter reading should be taken in the Spot OFF and 100 Micron settings. If any reading is out of range do not select any other operating conditions. Let the gun operate in the 100 Micron Spot condition for an hour and see if the out of bounds reading are improving. If not contact Service Physics Inc for trouble shooting help.
2. If the 100 Micron Spot parameters are in range and the vacuum is $< 5 \times 10^{-9}$ then adjust the 100 Micron spot for minimum size. The spots are adjusted using the Hand Held Spot Size Control Box. There is one pot for each of the 4 spots and two pots for each line. For the lines one pot is used to adjust the width and the other pot the length. The LED that indicates which set of pots to adjust is between the with and length pots for the spot currently in use.
3. If the vacuum is $< 5 \times 10^{-9}$ select the 200 Micron spot. Immediately check the spot size on the phosphor target. Make adjustments to insure the spot is no smaller then 300X300 Microns. Check the gun parameters against the final test values shipped with the gun. If a final test document is not available then Table 1 can be used as a guide. Let the vacuum return below 5×10^{-9} then select the next spot size. Immediately check and adjust the spot size and the parameter list of Figure 1.

FIGURE 1
Range of typical values for 9603 X-Ray Gun parameters

	OFF		100	300	500	800	L1	L2	L3
I OUT	0.05 – 0.25		1.49 – 1.51	4.90 – 5.10	9.90 – 10.10	19.5 – 20.5	4.90 5.10	9.0 10.5	19.5 20.5
I FIL	1.38 – 1.43		1.39 – 1.44	1.41 – 1.45	1.42 – 1.46	1.43 – 1.47			
V 2KV	2.28 – 2.32		2.28 – 2.33	2.28 – 2.32	2.28 – 2.32	2.26 – 2.32			
I 2KV	5.50 – 6.20		5.55 – 6.15	6.25 – 6.85	6.75 – 7.90	7.50 – 8.70			
V Q	0		0	0	0	0	150- 200	200- 275	350- 450
V F	8.10- 8.30		8.10 - 8.30	8.15 - 8.35	8.20 - 8.40	8.30 - 8.48			

4. For initial setup it is good to reduce the power for the 500 and 800 micron spots and then adjust the power to the operating value after the spot size has been checked. This can be done using pots R129 and R133. These two pots are found in the back right corner of the Analog Mother board. This board sits horizontal at the bottom of the front bay. There are 8 pots in a row. R129 and R133 are in the center of this group. They are the 4th and 5th pots counting left to right. The LED behind the pot will be on when the spot is selected. Turn the pot 10 turns clockwise to drop the power to its minimum value. Select the 500 Micron spot. Use the spot size control box to set the spot size. Then turn the power control pot counter clockwise to increase the power. It may take a few turns before power begins to increase. It would be best to take the 500 micron spot to 75 watts and then wait 15 minutes to see how the pressure reacts. **Re-set the spot size after obtaining full power. The voltage required to maintain the designated spot size increases as the power is increased.** If the pressure is OK then go on to 100 watts. For the 800 Micron spot use an intermediate power of 150 Watts. Then go to full power of 200 watts.

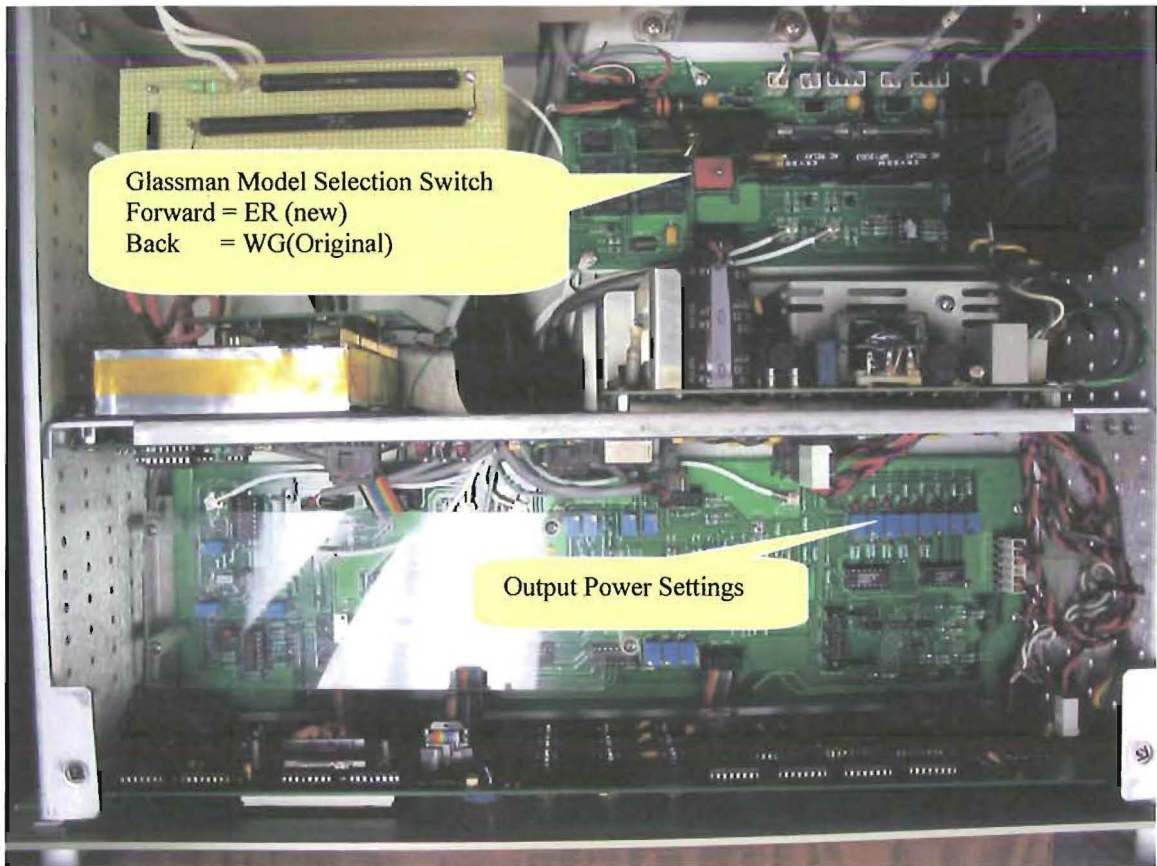
Note: We recommend that after the initial setup you make a table of all the actual values shown in table 1. This table should be kept in a convenient place so all users can monitor the values on a weekly basis.

5. After the gun is set up and has run for a day it is OK to return the Service/Operate toggle switch back to the operate mode. This will allow the supplies to ramp up to full power in about 3 to 4.5 minutes.
6. If a Line/Spot gun is installed then the L1, L2 and L3 line may be selected. The L1, L2, and L3 lines have the same power as the 250, 500 and 800 spots. The power density must be kept constant. A 500X500 Micron spot has an area of 250,000 square Microns. Any line with the same area may be used. ~~The silk screen suggests 200X800 Microns.~~ This should be changed to 250X1000. The user may modify this to meet specific applications as long as the area is 250,000 square Microns is maintained. The area for L1 is 40,000 and for L3 is 640,000. The practical line dimensions are L1 = 100X400 and L3 = 500X1200.
7. The controller can be set in the Computer Mode by pressing the front panel control. In this mode the computer can set the supply in Stand-by or in operate. The computer can also select any spot size and spot off.

Note: The X-Ray gun controller front panel is the same for both the spot controller and the line/spot controller. This allows any spot controller to be easily upgraded to a line/spot controller. If one of the line conditions is selected the controller will cause a spot gun to go to the appropriate power for that condition. As pointed out in section 9 above the 300 micron spot is at the same power as L1, 500 micron spot is the same as L2 and the 800 micron spot is the same as L3. IT IS RECOMMENDED THAT IF A SPOT GUN IS USED THE L1, L2 AND L3 CONDITIONS HAVE THE SPOTS ADJUSTED TO BE IDENTICAL TO SPOTS 300, 500 AND 800. THIS WILL AVOID ANODE PROBLEMS IF THE L1, L2 or L3 lines are accidentally selected.

Normal operation after initial setup

1. Turn on Model 9603 X-Ray Controller and verify the interlock light is on.
2. Turn on Glassman power supply
3. Press HV enable button on Glassman supply
4. Press the Start Filament button on the Model 9603 front panel
5. Press the Operate button on the Model 9603 front panel
6. Select the 100 micron spot.
7. After the Filament ramp, I2 KV Ramp and HV Ramp all complete their cycles all 8 status LED's should be on. The M&W flow should be on and stable.
8. Compare the operating values for each spot size against the actual initial values documented during the initial set up.



Glassman Model Selection Switch
Forward = ER (new)
Back = WG(Original)

Output Power Settings

Figure 1. Top view of 9600 Series Controller with cover removed.