TRION TECHNOLOGY

MINILOCK-ORION III
OPERATOR & MAINTENANCE MANUAL

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WARRANTY

The TRION system is guaranteed to be free of defects in workmanship and components. This warranty covers labor and parts for a period of **one year**, unless an extended warranty has been purchased.

The exclusive remedy for any breach or violation of the warranty is as follows: TRION TECHNOLOGY F.O.B CLEARWATER, FL will furnish without charge repairs to or replacement of the parts or equipment which proved defective in material or workmanship. No claim may be made for any incidental or consequential damages.

All transportation and shipping charges must be prepaid by the customer.

TRION TECHNOLOGY will inspect the equipment and decide upon such repairs or replacement as necessary. The customer will be notified of any charges incurred that are not covered by this warranty prior to accomplishment of any such repairs.

Any customer modification of this equipment, or any repairs, undertaken without the prior consent of TRION TECHNOLOGY will render this warranty void.

This warranty is expressly in lieu of all other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular purpose unless otherwise agreed in writing signed by TRION TECHNOLOGY.

SERVICE INFORMATION

NOTIFICATION OF EQUIPMENT PROBLEMS:

If the system has a failure or other equipment problems you must notify TRION TECHNOLOGY *immediately* in writing by either FAX to (727) 447-1581 or e-mail at service@triontech.com, addressed to the Service Coordinator. In addition please call the Service Department at (727) 447-1110 to schedule a service trip. Phone help is always provided free of charge. However, if the system is out of warranty a purchase order number will be required before a service trip is scheduled.

RETURN OF EQUIPMENT:

If an instrument is to be returned to TRION for service or for any reason, the following procedure should be followed:

Call the TRION TECHNOLOGY Service Department at (727) 447-1110 for a return authorization number (RMA). You may also e-mail TRION at "service@triontech.com" with any service related questions. If the unit is received without this number on the outside of the box it will be rejected by the Service Department.

Repack the instrument in the original shipping container. If this is no longer available, take special precautions to avoid damage to any fragile components. TRION will not be responsible for any damages incurred during shipment from customer to TRION. A shipping container may be purchased from TRION TECHNOLOGY for a nominal charge.

If the instrument is still under warranty, the only charges will be shipping costs. If the instrument is out of warranty, a purchase order will be required and you will be billed for all parts and service.

If you have any questions, do not hesitate to contact TRION Customer Service Department.

SYSTEM WARNING

SAFE OPERATING PROCEDURES AND PROPER USE OF THE EQUIPMENT ARE THE RESPONSIBILITY OF THE USER OF THIS SYSTEM.

TRION TECHNOLOGY provides information on its products and its associated hazards, but assumes no responsibility for the after sale operation and safety practices.

ALL PERSONNEL WHO WORK WITH OR ARE EXPOSED TO THIS EQUIPMENT MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS AND/OR FATAL BODILY INJURY.

DO NOT BE CARELESS AROUND THIS EQUIPMENT.

The following hazards are present on this system. Warning labels are affixed to the appropriate locations on the system to notify the user of potential danger.

HAZARD	**LOCATION**
 HAZARDOUS VOLTAGE Contact may cause electric shock or burn. Turn off and lock out system before servicing.	AC distribution module. Pump Contactor NEMA box. Inside RF generator. Inside chamber, at chuck.
 FLAMMABLE MATERIAL Contents may burn if exposed to flame source. Keep spark or flame sources from container.	Gas Cabinet.
 NON-IONIZING RADITION Contact may cause electric shock or burn. Turn off and lock out system before servicing.	Inside chamber with RF on. Inside RF generator with RF on.
 CHEMICAL HAZARD May cause skin/eye irritation. Wear gloves and eye protection while servicing.	Inside the chamber. Inside the gas cabinet.

HOT SURFACE
Contact may cause burn.
Turn off and lock out system before servicing.

Inside chamber on chuck.
Heater assembly inside system.

SYSTEM DESCRIPTION

GENERAL DESCRIPTION (OBJECTIVE)

The Minilock-Orion system is a plasma system designed to supply research and failure analysis laboratories with state-of-the-art deposition capability using single wafers or mounted parts (multiple size and batch).

The Minilock-Orion system is used for non-pyrophoric and toxic/pyrophoric PECVD processes . Films deposited: oxides, oxynitrides, nitrides, amorphous silicon and silicon carbide. Process gases: 100% silane, ammonia, TEOS, diethylsilane, nitrous oxide, oxygen, nitrogen, trimethylsilane and methane.

A Triode or inductively-coupled plasma (ICP) source is offered as an option for this tool. The Triode allows the user to create higher density plasma and thereby control film stress.

Typical process recipes and results can be found in the processing section of this manual.

Samples are loaded into the process chamber via the vacuum load lock. This feature increases user safety by preventing contact with the process chamber and any residual deposit by-products. The load lock also allows the chamber to remain permanently under vacuum thereby keeping the reaction chamber isolated from the atmosphere.

SYSTEM SPECIFICATIONS:

SIZE:	18 in (.5 m) wide 51 in (1.3 m) deep 53 in (1.4 m) tall – with Triode or ICP
MAX RF POWER:	600 Watts Triode, 1000 Watts for ICP 300 Watts PECVD
SYSTEM POWER REQ:	15A, 208Vac (phase-to-phase) 3-phase for the system. 20A, 208Vac (phase-to-phase) 3-phase for the remote pump box. (Amperage subject to change depending on pumps)
GAS CHANNELS:	7 Maximum
MAX WAFER SIZE - SINGLE:	3 in - 12 in (300 mm)
MAX WAFER SIZE - BATCH:	4 x 3 in 3 x 4 in 7 x 2 in

EQUIPMENT

The TRION TECHNOLOGY Minilock-Orion includes the following components:

EMERGENCY SHUT-OFF

To start the system, make sure the EMO button has been twisted to release and then press in the "MAIN" button. This will supply power to the computer, RF generators and turbo controller. Next, press in the "PUMP" button to turn on the chamber roughing pump. The computer will start and automatically load the system operation software.

To turn off the system, first exit the software. Then press in the "OFF" button. This will turn off the power to the computer (and thereby closing all gas and vacuum valves), the RF generators and the turbo pump. You must press in the "EMO" button to shut off the pump.

At any time the user may quickly shut down the system by pressing the "EMO" button. This will automatically shut off all AC power to the system including the computer, RF generators, turbo controller and the pump. This palm actuated button must be twisted to release. The system will NOT turn on until the user presses the "MAIN" button.

A full description and schematics for the EMO circuit are presented in the "SAFETY SPECIFICATIONS" section below.

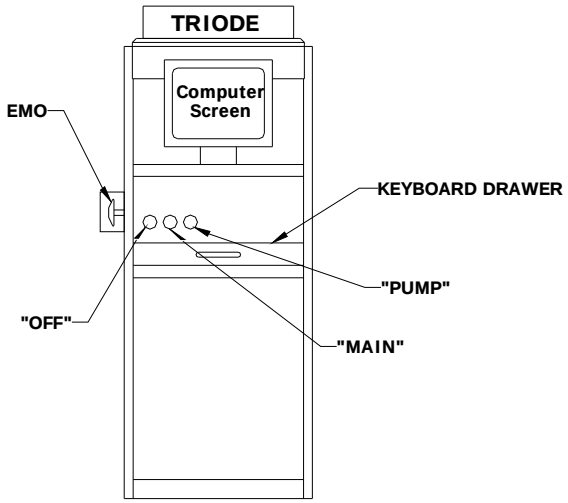


Figure 1. - System Frontal View

PROCESS CHAMBER

The process chamber is defined by the vacuum enclosure shown in Figure 2. below and made up of the, the chamber block and the PECVD transformer. During a process, the process gases (such as O_2 and CF_4) enter at the rear of the TRIODE, flow through the center of the TRIODE lid and exit into the chamber volume at the top center. The gas flow rates are controlled by mass flow controllers (MFC).

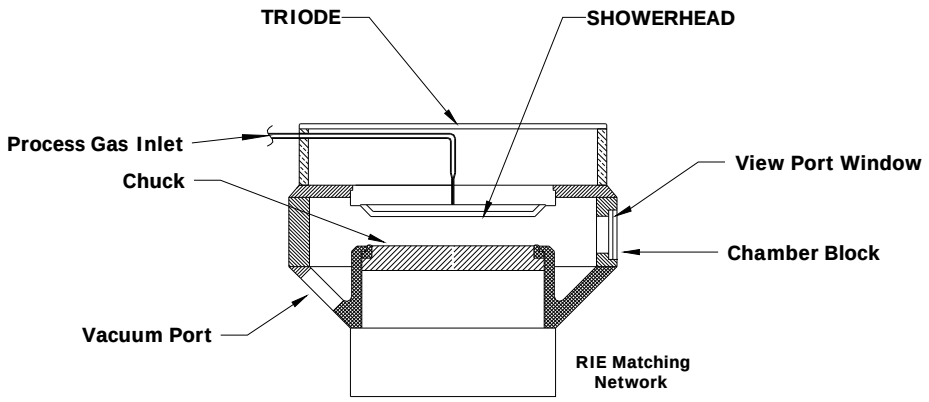


Figure 2. - Overall Process Chamber w/ TRIODE

In addition to the process gases, helium gas can be introduced into the chamber via the chuck as shown. The helium pressure on the backside of the wafer is controlled by an analog pressure controller and is set as a process variable in the recipe file on the computer. The purpose of the helium is to help cool the sample. Since the chuck has RF power flowing through it, samples can heat up over time and the helium helps maintain the sample at a reasonably cool temperature.

All of the gases entering the chamber are sucked out of the chamber through the vacuum port at the rear of the system. When the RF generators are turned on, then a plasma is created in the chamber. The glow discharge can be seen from the front view port window.

The chamber block has internal dimensions of 18” diameter x 2.50" high and will hold a 200 mm wafer on the chuck. The chamber, plenum and TRIODE base are constructed of hard anodized aluminum. The TRIODE has an 8” inner ceramic diameter x 4.00” tall.

The chuck, or bottom electrode, produces a negative DC bias, which increases ion bombardment and anisotropy while Depositing. The TRIODE is used as the primary plasma source and creates this plasma by inductively coupling the RF power through the ceramic and into the vacuum via the copper coil. The idea is to use the TRIODE to generate a high density plasma in the ceramic tube above the chuck. Then smaller amounts of RF power are supplied to the chuck to generate the DC bias. This DC voltage is the driving factor is accelerating the ions to the sample and thereby increasing Deposit rate and anisotropy.

Samples are loaded into the chamber by using tweezers to set them down onto the chuck. The TRIODE assembly also serves as the main lid. This assembly automatically lifts open using twin pneumatic cylinders which are controlled by the computer.

An E-chuck is available as an option to better cool the wafer during the process.

LOAD LOCK AND TRANSPORT ROBOT

The load lock chamber is connected to the process chamber via a gate valve. When the user loads a sample, he places the sample onto the robot end-effector. The system then pumps down the load lock to approximately 100 mTorr and then opens the gate valve. The arm moves into the process chamber where 3 pins lift the sample up off of the arm. The end effector retracts back into the load lock and the gate valve closes. The lift pins then lower the sample onto the chuck and the system is reading to process the part.

RF GENERATOR

Depending on process demands, TRION TECHNOLOGY supplies various RF generators and power ranges. Our standard generators are:

Comdel 1250 Watt, 13.56Mhz - ICP
Comdel 600 Watt, 13.56 Mhz.- TRIODE
Seren IPS 300 Watt, 100 Khz -PECVD

The power level and on/off functions are controlled from the process control computer. For further information see the RF generator manuals in the appendices.

The overall impedance of each network must be 50 ohms. The network for both the TRIODE and PECVD include the electrical impedance of the plasma. Plasma impedance is determined by a process pressure, RF power input, and the species of gases flowing into the chamber. If the overall impedance of the system is not 50 ohms, then a certain amount of RF power essentially bounces off the network and gets reflected back to the generator itself. This is called the *Reflected Power*. The actual RF power delivered to the chuck or the TRIODE plasma is given by:

RF Delivered = FORWARD POWER – REFLECTED POWER

In order to consistently deliver the proper power to the chamber, it is important to properly “match” the network impedance so that the *Reflected Power* is near zero. We use the variable capacitors to tune the impedance of the networks to keep the reflected power to near zero.

PROCESS CONTROLLER

The Minilock-Orion comes with a Intel Celeron based process control computer with a touch screen user interface. The TRION designed data acquisition board has 12 analog output channels (8 bit resolution) which control the 6 gas channels, process pressure, chuck temperature, and the RF power. The system also comes with 16 channels of 12 bit analog input. The DAQ board and controller are run by LabView for Windows software. All processing parameters can be programmed by the user and stored into recipes files on the hard drive and/or on a floppy drive. Up to fifteen process steps per recipe can be stored. The system controller also has a manual override which can be used to override the process endpoint and reprogram the process in-situ.

VACUUM SYSTEM

A schematic of the vacuum system is shown below in Figure 6. This consists of the chamber, load lock, gas distribution manifold, throttle valve, turbo pump and the two roughing pumps. A turbo pump may be purchased as an option.

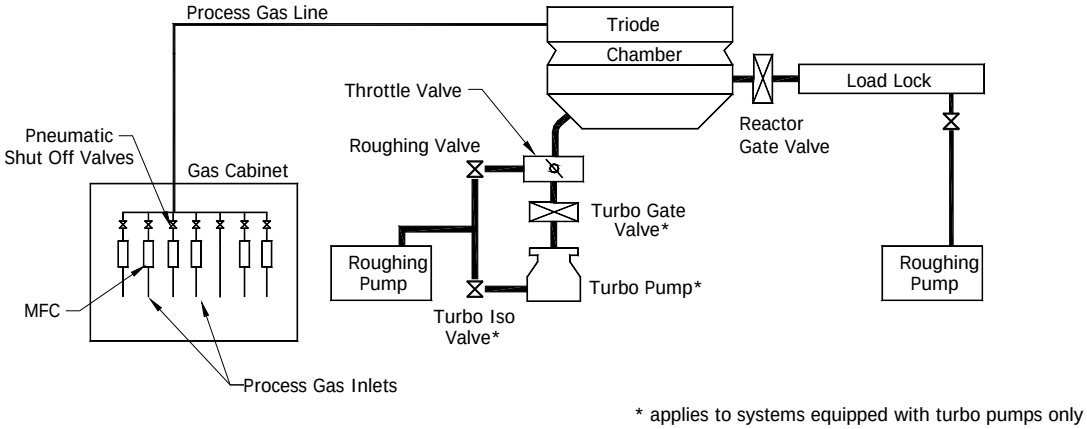


Figure 6. - Vacuum Schematic

Note: **Trion passes on the manufacturer's warranty on pumps to the end user and does not itself warrant them. It should be noted, that in any system using corrosive gases, that the roughing pump (Dry or oil lubricated) and the turbo pump must remain running *AT ALL TIMES*. Likewise, the N2 purge gas must remain on *AT ALL TIMES*. Pumps can seize if they are not kept rotating, purged and lubricated after being exposed to metal corroding gases. In the case of power failure, the end user must insure that the pumps are restarted, as soon as possible, after power is restored. The pump manufacturers, can, and will, void the warranty if this is not done.**

RECIRCULATING CHILLER

The standard chiller is capable of removing 2500 BTU/hr at 20C. It is used to cool the PECVD process chamber, the turbo pump and the TRIODE source. The temperature setpoint is controlled from the front panel on the unit and be can set anywhere from 5 to 25C. Trion Technology recommends the chiller be set to 25C for the Minilock-Orion system. For further information refer to the manufacturer's manual in the appendix of this manual.

SAFETY SPECIFICATIONS

SAFETY STANDARDS

The TRION Orion was built with standard safety requirements in mind. Purchased electrical components meet national UL standards where applicable and materials used in the machine's construction meet National Electric and Fire Codes. This machine has been found to meet SEMI S2-93 product safety guidelines.

The machine has the proper ANSI Z535 high voltage warning labels where high voltage is present and chemical warning labels where those chemicals are present.

LOCK OUT/TAG OUT

Electrical power is supplied from the house system to the Minilock-Orion at only two locations; the AC distribution and the process chamber Pump Control NEMA Box. Figure 7 shows a diagram of this electrical distribution system.

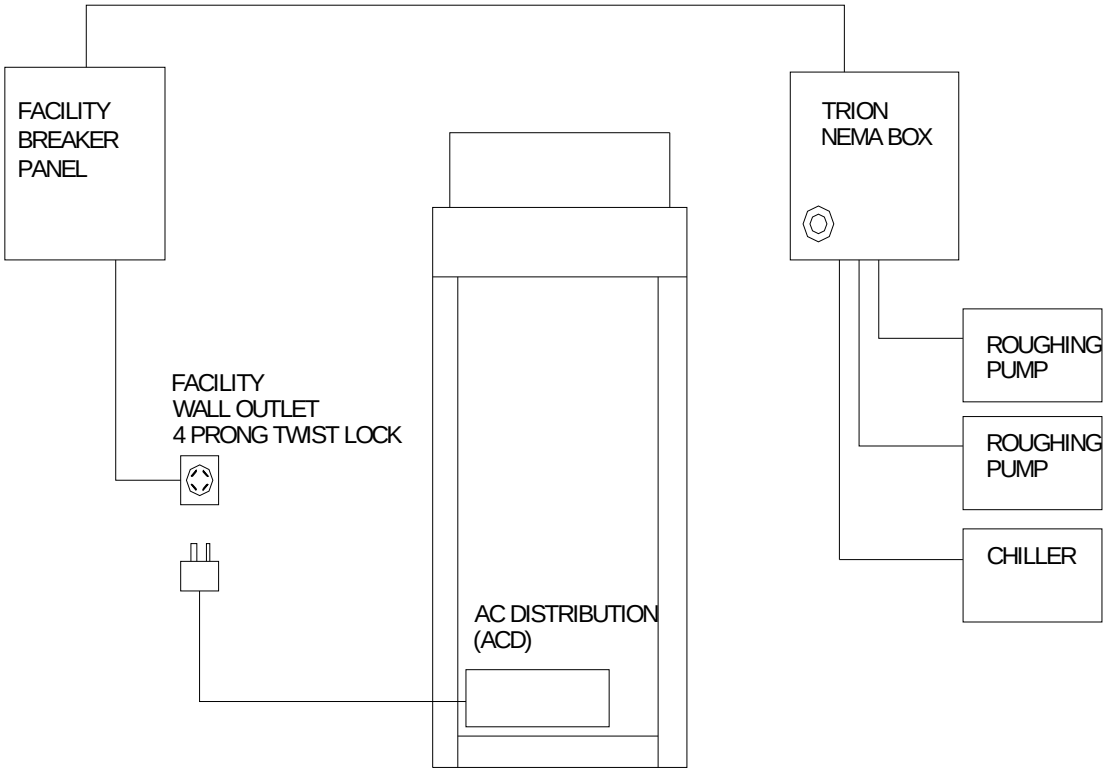


Figure 7 Main Electrical Distribution Diagram

The AC distribution is connected to the house breaker panel via a 4 prong twist-lock cord plug. The three-phase process chamber roughing pump is connected to the house breaker panel via the Pump Control NEMA Box. The power cord from the pump motor is hard wired through a knockout in this box to the main contactor inside. Just upstream of this contactor is a 15 Amp, 3-pole circuit breaker. The incoming power from the house is wired to the "LINE" side of this breaker. This NEMA box is to be pad-locked closed unless the house breaker has been locked out as described below.

PROCEDURE FOR SERVICE:

1. If any service work is to be performed on the system other than routine system maintenance, the user must first press the EMO button on the front panel of the system.

2. Next, the user must unplug the cord plug from the wall outlet.

3. The Cord lockout cap must be locked onto the cord plug. This lockout cap must have the tag "DANGER DO NOT OPERATE" attached to it and visible.

This will prevent any system component from turning on. It is now safe to remove modules and/or repair them in place following proper guidelines set down by TRION TECHNOLOGY. Although the Pump Control NEMA Box still has electrical power coming into the contactor, with the AC distribution unplugged this contactor can never be energized.

However, if service work needs to be performed on the process chamber roughing pump OR the NEMA control box, the following procedure must ALSO be followed.

1. Shut off the main house circuit breaker feeding the Pump Control NEMA Box.

2. Using the circuit breaker lockout, lock this circuit breaker in the OFF position. This lockout must have the tag "DANGER EQUIPMENT LOCKED OUT TO PROTECT WORKERS" attached and visible.

1. The user is now free to unlock the NEMA box if necessary and perform any service as needed.

EMERGENCY OFF SYSTEM

Figure 8 shows a diagram of the electrical control circuitry and buttons. There are 4 control buttons as labeled in the figure; EMO, OFF, MAIN, PUMP and PUMP EMO.

MAIN This button energizes the AC relay (K2) inside the AC distribution (ACD) module and:
- distributes 208VAC to the outlets
- turns on the computer

PUMP This button energizes the Pump relay (K1) inside the AC distribution and the 3-phase contactor (K5) inside the Pump control NEMA box. The results of pressing this button are:
- turns on the 3-phase chamber roughing pump and the single phase load lock

pump.

OFF This button de-energizes the AC relay (K2) and therefore shuts off the following:
- computer
- RF generators
- Turbo pump
- E-chuck power supply

PUMP EMO This button de-energizes the AC relay (K2), Pump relay (K1) and the 3-phase contactor (K5). This in turn shuts off all components and instruments on the Minilock-Orion system.

EMO This button de-energizes the AC relay (K2), Pump relay (K1) and the 3-phase contactor (K5). This in turn shuts off all components and instruments on the Minilock-Orion system.

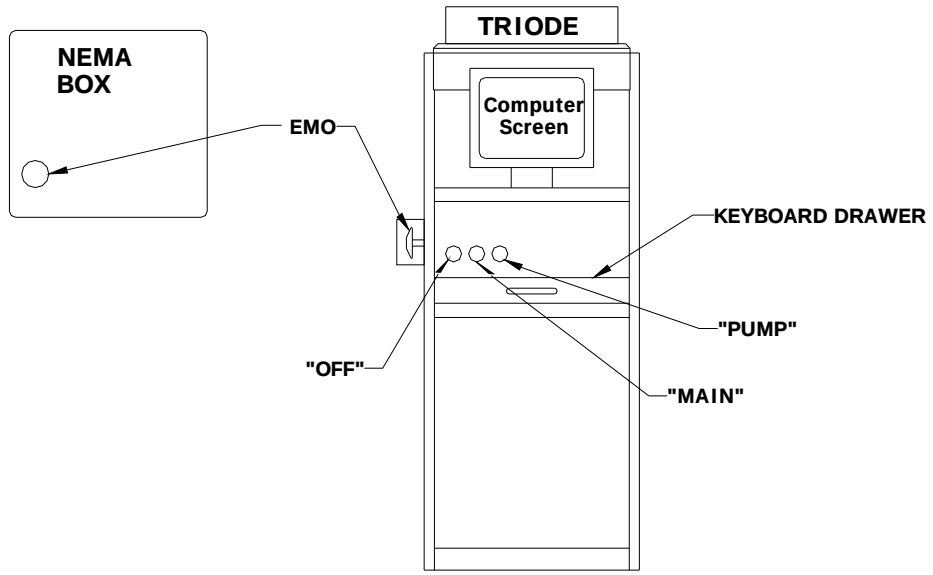


Figure 1. - System Frontal View

INTERLOCKS

The Minilock-Orion system has hardware interlocks that place the machine in a safe mode when tripped. These interlocks protect against a loss of water coolant flow and a loss of the house exhaust to the gas cabinet and pumps.

The table below describes the interlocks, their location and what they control in the advent of an error or alarm condition.

Interlock	Location	Purpose	Actions

Water flow switch.	Mounted to the chamber coolant outlet port.	To detect a loss of water coolant flow.	N.C. switch opens when the water flow stops. This tells the computer to shut down the gas valves, RF generator and heater.
Exhaust flow switch. Custmer supplied.	Mounted to the cabinet exhaust duct.	To detect loss of flow exhaust system.	N.C. switch opens when the exhaust flow stops. This tells the computer to shut down the gas valves and RF power.

EQUIPMENT ELECTRICAL DESIGN

All of the Minilock-Orion modules have been designed to be easily removed from the system. This design allows the user or the service engineer to remove and replace the module without exposing any electrical components.

Internal to the Minilock-Orion modules, all components with voltages greater than 24 volts have either protective plastic or metal covers. The electrical distribution module has no user serviceable parts and is securely closed at the factory. All covers that house dangerous voltage have ANSI Z535 complaint warning labels.

All electrical components, wiring, and grounding complies with National Electrical Codes.

CHEMICAL USE

The following gases will be used in this Minilock-Orion system:

Gas Number	Gas	MFC Flow rate in Sccm
Gas 1	NH3	100
Gas 2	N2	500
Gas 3	CF4	500
Gas 4	O2	500
Gas 5	AR	400
Gas 6	N2O	500
Gas 7	PH3	200
Gas 8	CH4	500
Gas 9	SiH4	100
Gas 10	B2H	200
Gas 11	H2	200

When the Deposit process is complete, the process controller automatically maintains a vacuum in the chamber for 20 seconds after processing to insure complete removal of any residual by-products. (This time can be increased through software if desired). A follow on process step can be added that purges the chamber with nitrogen to further clear out residual gases. The controller is also designed such that the reactor remains under vacuum when the system is idle.

The load lock eliminates the need for the user to ever open the chamber during normal operation. Therefore there is no contact with process gases during normal operation.

EMISSIONS

There should be no harmful chemical emission during the normal operation of this equipment. The reaction chamber and vacuum pumps are sufficiently exhausted to prevent this occurrence.

LABELING

All piping is labeled with the name of the gas contained within. All system wiring is color coded in accordance to NEC requirements. All hazardous locations are labeled with ANSI Z535 compliant labels.

EARTHQUAKE PROTECTION

The system will not overbalance until it is tipped more than 22^{o} and is sturdily built into a 1.5" square extruded aluminum frame. In addition, the system should be bolted to the facility floor. Seismic restraints have been provided to securely lag the system to the floor.

MECHANICAL SAFETY

There are no sharp protruding edges that can be hazardous. The only moving parts are the robot end effector and the gate valve between the load lock and the process chamber. The robot motor's stall torque is low enough that no injury will occur should the end effector move while the user's hand is in the way. The reactor and load lock lid switches cut off 12VDC to the pneumatic solenoid valve that controls the gate valve movement. This opens the valve and prevents the valve from ever closing on the user's hand should it be placed in the passage between chamber and load lock.

"WHAT IF" HAZARD ANALYSIS

The following table shows the risk assessment of the Minilock-Orion system.

What If?	Consequences	Protection
Computer lockup	Process continues to run at last setpoints	none
Computer failure	Setpoints go to zero and all normally closed valves close	Failsafe
Loss of cooling water	RF generation ceases, process is impacted, potential o-ring damage	Flow switch cuts off all RF power and gas flows
Chiller coolant leak	Wet floor	Small coolant volume, well placed and baffled electrical enclosures
Toxic Gas Leak	Hazard to personnel	Customer supplied gas detectors are wired into Trion system and EMO the system in the event of a toxic gas leak

INSTALLATION

INSPECTION

The Minilock-Orion is completely tested and inspected at the factory before shipping. It is packed in specially designed shipping containers to protect it from damage in normal handling. **Save these containers, if possible.** Inspect the shipping containers before unpacking the instrument. If there are signs of damage to the containers, make note of the damage and report it to the shipping company and TRION TECHNOLOGY immediately.

Inspect the instrument for any damage to the enclosure, the chamber, switches, and other components. If there are any damaged or missing components, notify your sales representative or the TRION Service Department.

FACILITIES

The Minilock-Orion requires the following facilities for operation:

AC POWER	208VAC 15A, THREE PHASE - 4 PRONG TWIST LOCK 1 Ground 3 Hots 208VAC 20A THREE PHASE – PUMP CONTROL BOX 1 Ground 3 Hots (Note: Amperage requirements subject to change depending on pumps.)	
EXTERNAL GASES	NITROGEN	- 80 psi, 1 lpm (For Pneumatic acuation)
	OXYGEN	- 15 psi, 500 sccm (Process Gas)
	CF4	- 15 psi, 100 sccm (Process Gas)
	ARGON	- 15 psi, 200 sccm (Process Gas)
	NH3	- 15 psi, 100 sccm (Process Gas)
	SiH4	- 15 psi, 100 sccm (Process Gas)
	PH3	- 15 psi, 100 sccm (Process Gas)
	H2	- 15 psi, 200 sccm (Process Gas)
	B2H6	- 15 psi, 200 sccm (Process Gas)
	N2O	- 15 psi, 200 sccm (Process Gas)
	NH3	- 15 psi, 100 sccm (Process Gas)
	Note: all fittings are 1/4" VCR)	
PUMP EXHAUST	Flow rate and fitting size depend on pumps supplied or purchased	
CABINET EXHAUST	200 cfm per cabinet, 6” ID Duct. Duct material must be non-flammable. If local authorities require abatement then follow the pertinent regulations for the chemistries used.	

COOLING WATER	2.0 LITER/MIN, 3/8” SWAGELOCK FITTINGS 50/50 Mixture of Ethylene Glycol and DI water

INSTALLATION PROCEDURE

1. Place the chamber roughing pump as close to the chamber as possible to minimize conductance losses. Place as shown in Figure 9.

2. Place the smaller load-lock roughing pump also as shown in Figure 9.

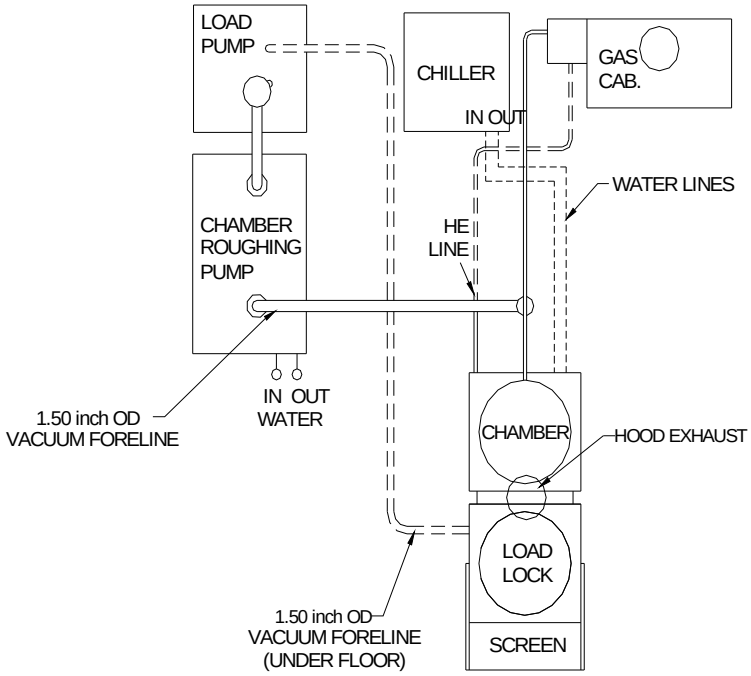


Figure 9. - System Layout

3. Use the flexible vacuum hose to connect the load lock vacuum valve to the inlet on load lock pump. Since the line is flexible the pump can be located anywhere that is convenient.

4. Connect the NW-40 stainless flex line to the outlet of the chamber roughing valve.

5. Connect a solid 1.5” stainless section of pipe from the flex line to the inlet flange on the pump.

6. Mount the Pump Control NEMA box to the facility wall near the system.

7. Wire both the three-phase chamber pump and the load lock roughing pump to the contactors inside the PumpControl NEMA box.

8. After ensuring all circuits are de-energized, connect house power to the breaker inside the Pump Control NEMA box. This is three-phase, 208VAC with a ground and 20A service.

9. Connect the external gases to their appropriate inlets on the back of the system gas enclosure. These lines should be have 1/4" welded VCR fittings.

10. Connect house nitrogen to the inlet of the solenoid pack. Set line pressure to 80 psi.

11. Connect the RG8 cable between OUTPUT on the Seren RF Generator and the RF In on the PECVD transformer.

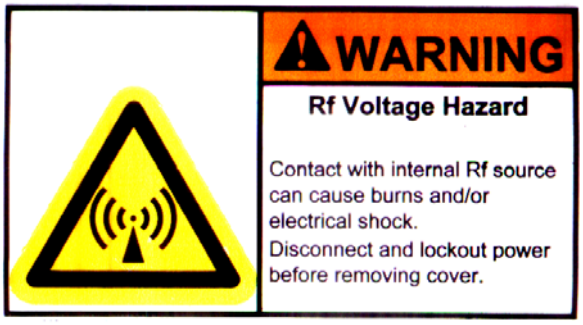
12. Connect the second RG8 coax cable from the outlet of the Comdel RF generator to the inlet on the TRIODE.

13. Connect the control cable between the process module and the USER port on the rear of the RF Generators.

14. Connect the 6" cabinet exhaust to the house exhaust. Connect the 1” chamber pump and load lock roughing pump exhaust to the house exhaust.

15. Plug AC distribution cord into wall socket with 208VAC, 15 Amp , 3-phase service.

RF WARNING



This machine uses RF frequency power. Care should be taken in its use. DO NOT operate this machine with any RF component enclosures open. These components should be service by trained personnel only.

The frequency and power levels of the RF generators are as follows:

Comdel CB1250	1250 Watts maximum power @ 13.56 Mhz- ICP
Comdel CB600	600 Watts maximum power @ 13.56 Mhz- TRIODE
Seren L301	300 Watts maximum power @ 100 Khz

PROCESS CONTROLLER OPERATION

NOTE:
This section (pages 23 thru 27) will be updated before Sunpower final tool Stool installation

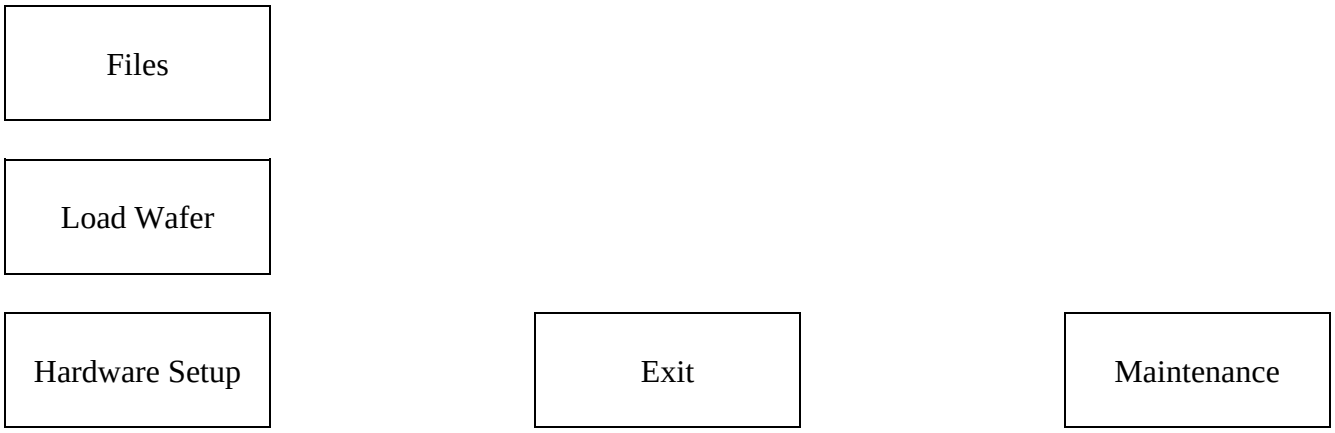
INTRODUCTION

LabView is a Windows based application that controls the I/O for the Minilock-Orion system. It is run on a Pentium based industrial PC.

The code starts up when power is supplied to the Minilock-Orion by pressing the ON button on the lower left front bar. The control software consists of a number of panels, or screens which will be described here in the order that they appear.

MAIN PANEL

When the machine is first brought up from no power, the Main panel will display 6 buttons;



In order to initiate a process, a recipe file must first be obtained from either the hard disk or a floppy. This is done by touching the Files button.

FILES PANEL

When this panel opens up, the current recipes on the hard disk located in the C:\RECIPES directory are displayed in the main boxes (or buttons). If you wish to retrieve a recipe from a floppy, touch the Floppy button on the lower portion of this panel and those recipes in the root directory of the floppy will then be displayed in the above boxes. Touching the Hard Drive button will of course, redisplay those files from the hard disk.

To load the desired recipes, simply touch the button labeled with the file name you want. After a second or two, the Save button will become visible on the bottom of this panel and a message in the upper right will confirm the current selected recipe file name. Touching the Exit button will keep this recipe and return you to the Main panel.

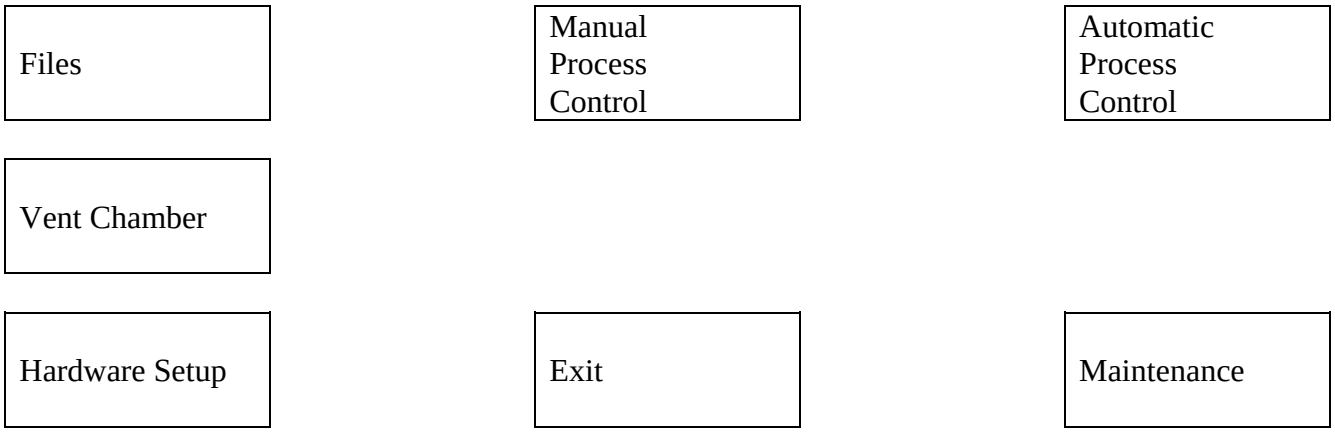
There currently are only two methods of modifying recipes. The first is to use the buttons in the Manual Process panel described below. The other method is to Exit the Main panel which will return you to the Windows environment with the Program Manager on the screen. From there, go back to DOS and change directory to C:\RECIPES and examine the contents. All recipe files have the filename extension .PGM.

To modify an existing recipe, simply Edit the file (they are in ASCII format). The recipe is grouped by steps and the process variables for each step can be changed with a simple text editor. A zero time entry in the Deposit Time field will tell the software that the previous step is the last step to process. For example, if the Deposit Time entry for step #2 is zero, then the program only processes the first step.

The only way to create a new recipe file is to enter DOS and copy an existing file to a new filename and then edit the process variables.

To re-enter the software from DOS, simply type WIN at any DOS prompt.

Once a recipe has been loaded and the Exit button has been touched from the Files panel, the Main panel will now have two additional buttons;



To run a process in the manual mode, or to program in the process variables for a recipe, touch the Manual Process Control button.

MANUAL PROCESS CONTROL PANEL

The manual process panel displays all process variable set points and the corresponding reads. In addition to this, buttons on the bottom of the panel allow the User to selectively turn on and off vacuum, gas flow, and RF power. Buttons disappear when they are not allowed to be used in a particular sequence.

In order to change the value of a process variable, simply touch on that variable's Set point value box. A keypad will pop up for numeric data entry for the variable. Remember, any changes made to the process will only be kept until a new recipe is read in. In order to permanently save your changes to the current recipe file, you must go back to the Files panel and touch the Save button.

The "AIM GAUGE" button on the upper left of the screen turns on and off the AIM high vacuum gauge. The gauge can only be activated when the chamber pressure is below 10 mTorr and with the "VACUUM ON" and "PRESSURE ON" buttons on (or green). A few seconds after the gauge is turned on, then the "AIM READ" value will show the vacuum level in Torr, not mTorr.

The manual control panel has numerous buttons on the bottom of the panel. The Previous Step and Next Step buttons allow you to move to different steps within the recipe.

The "EXIT" button will shut everything off and return you to the MAIN PANEL.

The "VACUUM" button opens the reaction chamber roughing valve and pumps down the chamber only. As the button is pressed, it shows you which state the valve in is, either On or Off. The "PRESSURE" button merely opens the Baratron isolation valve. After this is on, the reading for pressure on the upper left screen will show the current chamber pressure in mTorr.

Only after the Vacuum and Pressure buttons have been activated will the button for Gas come on. When you touch the Gas button, the gases that have been set to a non-zero value will begin to flow into the chamber. The exception to this is if either oxygen or nitrous oxide and diborane or phosphine are attempted to flow together. In either case, the diborane and/or phosphine will automatically shut off. This is controlled by the circuitry in the Gas Compatibility & Interlock box.

At this point the turbo pump will engage and the throttle valve will begin to regulate pressure to the value set. Turning off the gases is achieved by touching the Gas button again or by touching either the Pressure or the Vacuum buttons. This is to ensure that no gas flows unless the chamber is being pumped on. Changes to gas flows, or any process variable, can be made at any time during manual operation by simply touching the Set point valve and entering new data. Also after the Gas button is on, the Load and Unload Wafer buttons disappear so that you cannot perform those functions while gas is flowing.

The RF button becomes visible once the gases are flowing. When activated, the RF power is applied to the TRIODE and a plasma is generated. The Deposit timer will count up from zero. The RF power will NOT automatically turn off, no matter what the Deposit Timer set point is. You must touch the RF button again to shut off the plasma. Turning off the gases or vacuum will also shut off the RF power. The reading for the Reflected Power is also displayed.

AUTOMATIC PROCESS CONTROL PANEL

This mode of control has the computer run the entire process (up to 16 different steps). This includes pumping down the chamber to a base pressure, turning on gases, adjusting pressure and turning on the RF for the requested Deposit time. The Deposit timer will count down in the Automatic mode, which is different than the manual mode. Unlike the Manual process panel, the process variables are not

changeable in this panel. The only button active here is the Abort button. This will shut everything off and return you to the Main panel.

If the pressure in the chamber cannot reach the base pressure set, then an error message will come up stating this and the process will abort. This is to prevent flowing gases when the chamber pressure it too high and a possible leak, or faulty pump, is present.

HARDWARE SET-UP PANEL

This panel can only be accessed by certain personnel with the proper passcode. The buttons on this panel allow certain settings to be changed for each system. The current values have been set by Trion and should not be changed without first consulting with Trion.

Once the user enters the hardware setup panel, there are additional buttons for setting up various parameters for the system.

INITIATION

As the system initializes, if first homes the robot and then closes the reactor gate. Then it opens the chamber roughing valve as the turbo is spinning up to speed. After 15 seconds the pressure isolation valve opens and the computer reads the chamber pressure. If it is not below 100 mTorr, then an error message is displayed on the screen. If the chamber pressure is below 100 mTorr, then the pressure isolation valve closes. All other valves are closed.

MANUAL PROCESS CONTROL

When this screen is first entered every valve is closed except for the load lock turbo isolation valve. The reactor gate is closed and the chamber roughing valve is closed also. The user has control over the roughing valve via the “VACUUM OFF” button. When the user exits this screen, all valves are closed except for the chamber roughing valve and the load lock turbo isolation valve. This is in order to keep the chamber under vacuum and keep the chamber turbo pump up to full speed.

AUTOMATIC PROCESS CONTROL

When entering this screen the chamber roughing valve is opened along with the load lock turbo isolation valve. The computer controlled sequence continues as described in the software control section. When either the process ends, or the “ABORT” button is pressed, all valves are closed with the exception of the chamber roughing valve and the load lock isolation valve.

EXIT PANEL

When the User presses the Exit button from the Main panel, a window will pop up asking the User if he/she is sure they want to exit the software. Touching OK will shut all solenoids and return the User

to the DOS environment. To return to the LabView® software, either type WIN at any DOS prompt or cycle the AC power to the system.

MAINTENANCE

Like the Hardware Setup Panel, the maintenance panel is accessible only by trained personnel with the proper passcode. The functions on this panel allow the User to have a fine level of control over most aspects of the system, but does not have any logic to prevent nonsequential events. Therefore, the person using these panels must be trained and understand what each function does so as not to damage the system.

START UP PROCEDURE

After the machine has been properly installed; you can begin operation in the following manner:

1. Ensure that the reactor lid is closed.
2. Turn on the vacuum pumps by pressing the “PUMP” button from the front console.
3. Verify the pneumatic nitrogen supply is at 80 psi.
4. Turn on the main power by pressing the “ON” button from the front console.
5. Verify that the RF generator display and the computer console is lit.
6. Ensure that process gas bottles are open and their outlet pressure is adjusted to 15 psi.

The system is now ready for use. The software will automatically load and initialize the hardware. Following the procedures outlined in the Process Controller section above to run a sample.

VACUUM CHECK

When first starting a machine it is always advisable to check the vacuum integrity of the process chamber.

1. Enter the Manual Process Control panel.

2. Turn on “VACUUM” button so that it is green.

3. Wait 15 seconds.

4. Touch the “PRESSURE” button so that it turns green.

5. Monitor the chamber pressure on the left hand display, it should fall below 100 mtorr in less than 30 seconds.

6. Wait until the pressure has stopped decreasing and that any moisture present in the chamber has had time to outgas.

7. Note the base pressure.

8. Turn off the “VACUUM” button. The main vacuum valve is now closed, if the system has a leak the pressure will slowly rise in proportion to the size of the leak. The system pressure should not rise more than 15 mTorr/min over 5 minutes.

SYSTEM MAINTENANCE

GENERAL

The Trion Minilock-Orion was designed in a highly modular form. There are eight fundamental modules:

1. The AC Distribution Module
2. The Process Control Module (Computer)
3. The RF Generators
4. The Reactor
5. The Load Lock and Robot
6. PECVD Transformer
7. The Chamber Vacuum Pump and the Load Lock Vacuum Pump
8. The TRIODE

Each of these modules has been designed for easy removal. This design concept eliminates the necessity of field repair work on the component level.

MODULE REMOVAL

If a module has become faulty or damaged it can easily be exchanged with a new one. However, the following modules should only be removed and replaced by trained TRION TECHNOLOGY personnel:

- TRIODE
- PECVD Transformer
- Process Controller
- Robot

All other modules can be removed by any trained maintenance personnel on site and replaced with new or loaner units from TRION TECHNOLOGY. The general procedure for removing any module is the following:

1. Turn off the system power by pressing the EMO button on the front panel.
2. Disconnect any cables to the module.

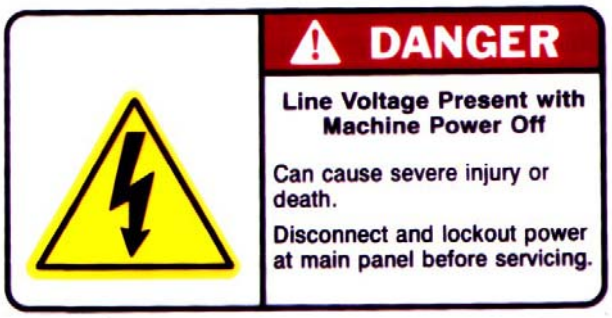
3. Disconnect any water coolant hoses to the module and secure loose hoses so that they do not spill water over the equipment.

4. Unplug the module's power supply cord if applicable.

5. Remove any mounting bolts from the system and slide the module out.

6. For pumps, disconnect the inlet and outlet lines and use 2 people to lift or move a pump.

AC DISTRIBUTION



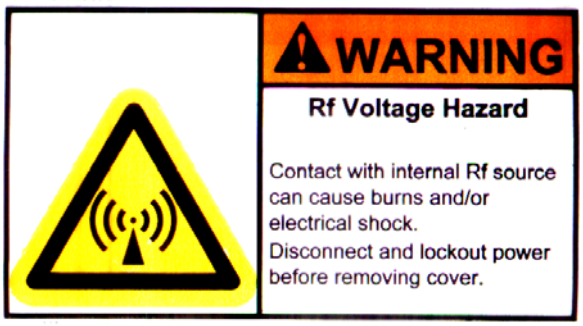
ONLY TRION TECHNOLOGY PERSONNEL SHOULD EVER WORK ON INTERNAL COMPONENTS TO THIS MODULE.

The AC Distribution module contains two basic components, the breakers and the AC relays. Since the entire unit is riveted closed, it should be removed and returned to TRION in the event of a failure. A replacement module will be sent out immediately.

PROCESS CONTROL MODULE

In the event of failure, call the TRION TECHNOLOGY service department to schedule a visit to replace this module. If the system is out of warranty or faster service is required (as if overseas) then the computer can be removed and replaced by the customer. To do this, follow the general guidelines above, paying particular attention to the proper locations of each instrument cable.

RF GENERATOR

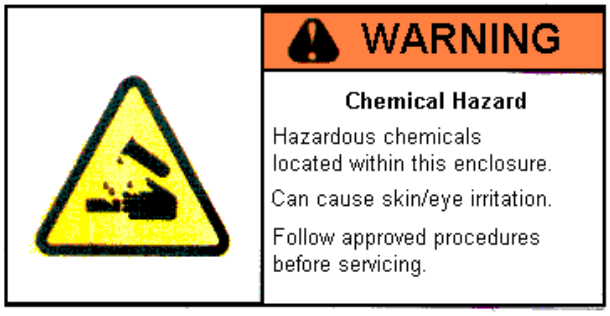


The RF Generator is a self-contained unit and should only be worked on by trained personnel. In the event of failure, disconnect the unit and send it to TRION for repair. Loaner modules are available.

REACTOR

The Reactor does require periodic, physical cleaning. The frequency of the cleaning will depend upon the process used and the frequency of use. Contact a TRION service engineer to determine how often the reactor should be cleaned. The cleaning procedure is similar to cleaning laboratory glass wear, the procedure is as follows:

Trace amounts or organic and fluorinated compounds may be present in the reactor after plasma cleaning. The physical cleaning of the chamber should be performed in a ventilated room. Gloves and eye protection should be worn.

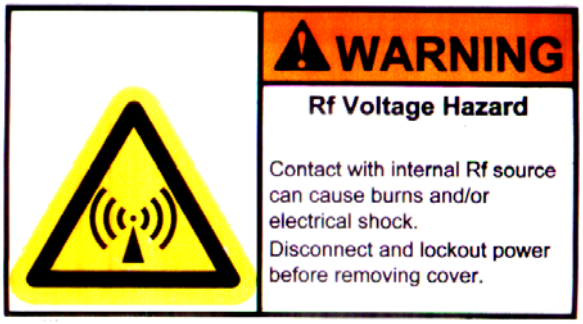


GLOVES MUST BE WORN BY MAINTENANCE PERSONNEL!

1. Run the preprogrammed plasma CLEAN process.
2. Vent the chamber to atmosphere and open the lid.
3. Scrub any hard to remove deposits with an abrasive pad.
4. Wipe out the chamber with DI water on a chem wipe.
5. Wipe out the chamber with Isopropyl Alcohol on a chem wipe.
6. Close the lid and rerun the CLEAN process again.

Any gloves and wipes used may be contaminated with IPA and/or deposition by-products and should be disposed of in accordance with local regulations.

PECVD & TRIODE RF TRANSFORMERS



The RF transformers on both the TRIODE and PECVD are self contained and sealed assemblies bolted to the system. These modules should only be worked on by trained TRION TECHNOLOGY personnel. In the event of failure, remove the sealed module and send it to TRION TECHNOLOGY.

VACUUM SYSTEM

The TRION Orion uses a corrosive series fomblinized pumping system. This system is relatively maintenance free, and should only require periodic changing of the inlet dust filter and oil. If your pump was purchased from TRION TECHNOLOGY, reference the manufacturer's vacuum pump manual contained in this manual.

GLOVES MUST BE WORN WHEN FILLING OR CHANGING PUMP OIL!

Gloves and any wipes that are used may be contaminated with Fomblin or Krytox pump oils and must be disposed off in accordance with local regulations.

PERIODIC MAINTENANCE SCHEDULE

Below is a table of TRION'S recommended periodic maintenance schedule.

Task	Description	Schedule
Chamber Plasma Clean	O2 "CLEAN" recipe for at least 600 seconds	Daily
Chamber Hand Clean	Wiping inside of chamber & lid with DI water & light ScotchBrite. Cleaning with IPA and running O2 clean plasma	Bi-Monthly
O-ring Inspection	Remove, inspect and re-grease all o-rings (replace as necessary)	Yearly
Pump Oil Level	Check sight glass on chamber and load lock roughing pumps for oil level. Should be within marks. Fill as needed	Monthly
Pump Oil	The oil in both load lock and chamber roughing pumps should be replaced with new fomblin YVAC 06/6.	Yearly

Procedure for Interchanging Trion Minilock-Orion Triode with Trion ICP

Important Note:
This procedure involves lifting that requires two people.

1. Shut off RF power
2. Vent chamber
3. Shut off power and lock-out system
4. Shut off power to chiller and water supply. Disconnect and plug both ends of both Triode water lines, being careful not to create spillage.
5. Provide a rollaway table or cart, approximately the same height as top of chamber, 45” from floor and position it on the left hand side of the system.
6. Disconnect gas lines entering Triode and plug open lines coming from gas cabinet. (Figure 1&2)

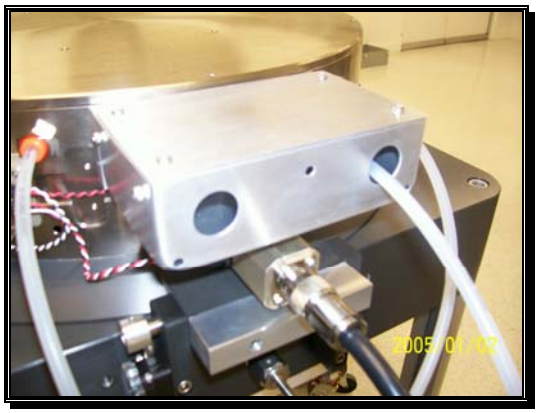


Figure 1

7. Remove the three (3) 8-32 screws that secure the gas junction box to the Triode case, and slide junction box away from Triode about 2 inches.(Figure 2)

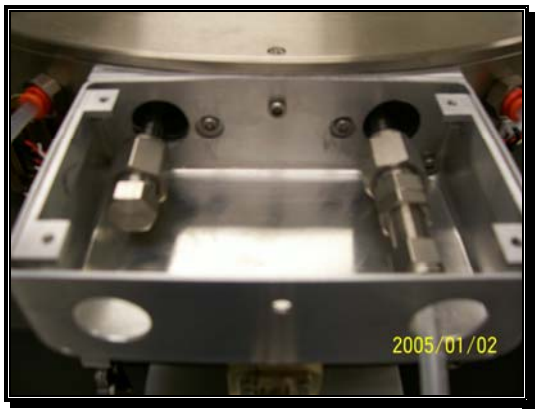


Figure 2

8. Remove the Switch Cam on the left hand end of the hinge block by loosening the set-screw and sliding it off the hinge pin (Figure 3)
9. Remove the two hinge blocks at rear of chamber by removing the (4) 10-32 SHCS’s, and sliding them off the hinge pin. (Figure 3)

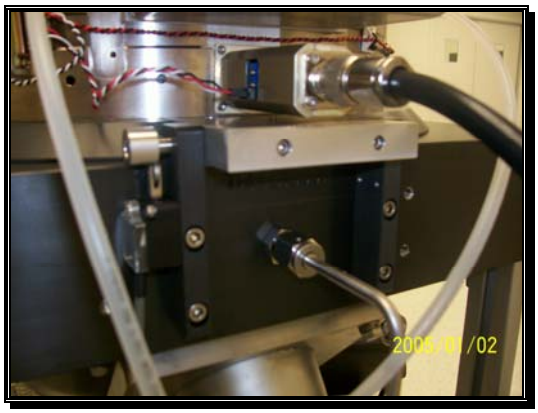


Figure 3

10. Disconnect RF cable and 25 pin "D" connector cable from Triode. (Figure 3)
11. Lift Triode approx 3/4" and move it directly forward toward the Load-lock, approximately 3". **Do not slide Triode on the surface of the chamber as this could damage the chamber o-ring.** Lift Triode to the left onto the roll-away cart. (Figure 4)

Figure 4

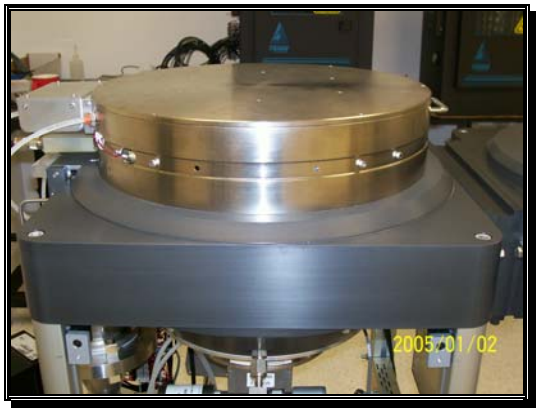


Figure 5

12. Repeat the above steps in reverse for the ICP; have the ICP on a roll-away cart, to the left of the machine, carefully lift the ICP, aligning the gas lines and gas line access holes in the back and then carefully positioning the ICP over the chamber and lowering it. ". **Do not slide ICP on the surface of the chamber as this could damage the chamber o-ring** (Figure 4 & 5)
13. **Important note: The ICP and Triode external enclosure and base plate are identical with respect to the mechanical hinge and other connections.**
14. Reconnect the Hinge blocks per step 9, Figure 3
15. Reassemble the Hinge interlock Switch Cam per step 9, figure 2.
16. Reconnect water lines to the ICP
17. Connect the cables RF and ICP control cable supplied with the ICP kit and per the Interconnect Drawing supplied with that kit (TRION Kit # TRN100313)
18. Fasten the Gas junction box to the ICP enclosure using the (3) 8-32 x ½" screws removed on step 7 (figure 2)
19. Reconnect the the gas line fittings and replace the junction box cover using 4 phillips head 6-32 x.3/8" screws.
20. You are now ready to return power to the system.

Procedure for removing and servicing Minilock-Orion Triode when Plumbed with fixed double wall gas lines.

Important Note:
This procedure involves lifting that requires two people.

To remove the Triode when plumbed with fixed double-wall tubing, follow steps 1 – 20 above. (Again, the mechanical interfaces of the ICP and Triode are identical.)