POLYTEKNIK AS
HOUSE OF COATING TECHNOLOGY

Cryofox Explorer 600

User guide

User guides for Cryofox Explorer 600

This section is intended for users of the machine. It includes guides for the different processes in the Cryofox explorer.

Open/Close Main chamber process guide

This process is used when the user want to open the main chamber. This is done if more evaporation material is needed, the quartz crystal needs to be changed or if general maintenance is needed.

Guide to open/close main chamber

1. Load lock must be vented and no other process running.
   Push the “Open Main Chamber” button and then push the “Process Start/Stop” button.
2. When the chamber is vented open the door and use the earth rod on the e-beam and the two magnetrons.
3. Follow the cleaning guide described in the next section.
4. Fill up the four e-beam pockets with evaporation material (refer to Temescal Supersource2 manual).
5. If needed change the quartz crystal in the thickness monitor. Clean the crystal holder before mounting a new crystal.
6. Push the “Close Main Chamber” button and the “Process Start/Stop” button and close the main chamber.

Notice

When the “main chamber close” program is running the process can not be stopped.

Notice

To minimize vacuum system contamination, always wear rubber gloves or lint-free linen gloves when handling the inside of the main chamber and any components inside the chamber.

WARNING

There is no counter resistance in the e-beam, therefore crucible select is only to be operated without any personal operating inside the main chamber.

Cleaning and maintenance of the main chamber

When opening the main chamber the following cleaning procedure should be used

1. Use a vacuum cleaner on the system walls, the shutters and the e-beam to remove all flakes of coating and other rough contamination.

2. Using a pair of tweezers clean the crucibles of the e-beam.
3. If further cleaning is needed then use isopropanol.
4. If needed change the object glasses in the spectacle glass of the chamber door.
5. Finish by checking there is no contamination around or under the e-beam.

Process trend

This interface is a data and info screen when running a coating process. Explanation of this interface is shown in Figure 1 Process Trend. To start a process press “Coating Process” and “Process Start/Stop” and close the load lock chamber.

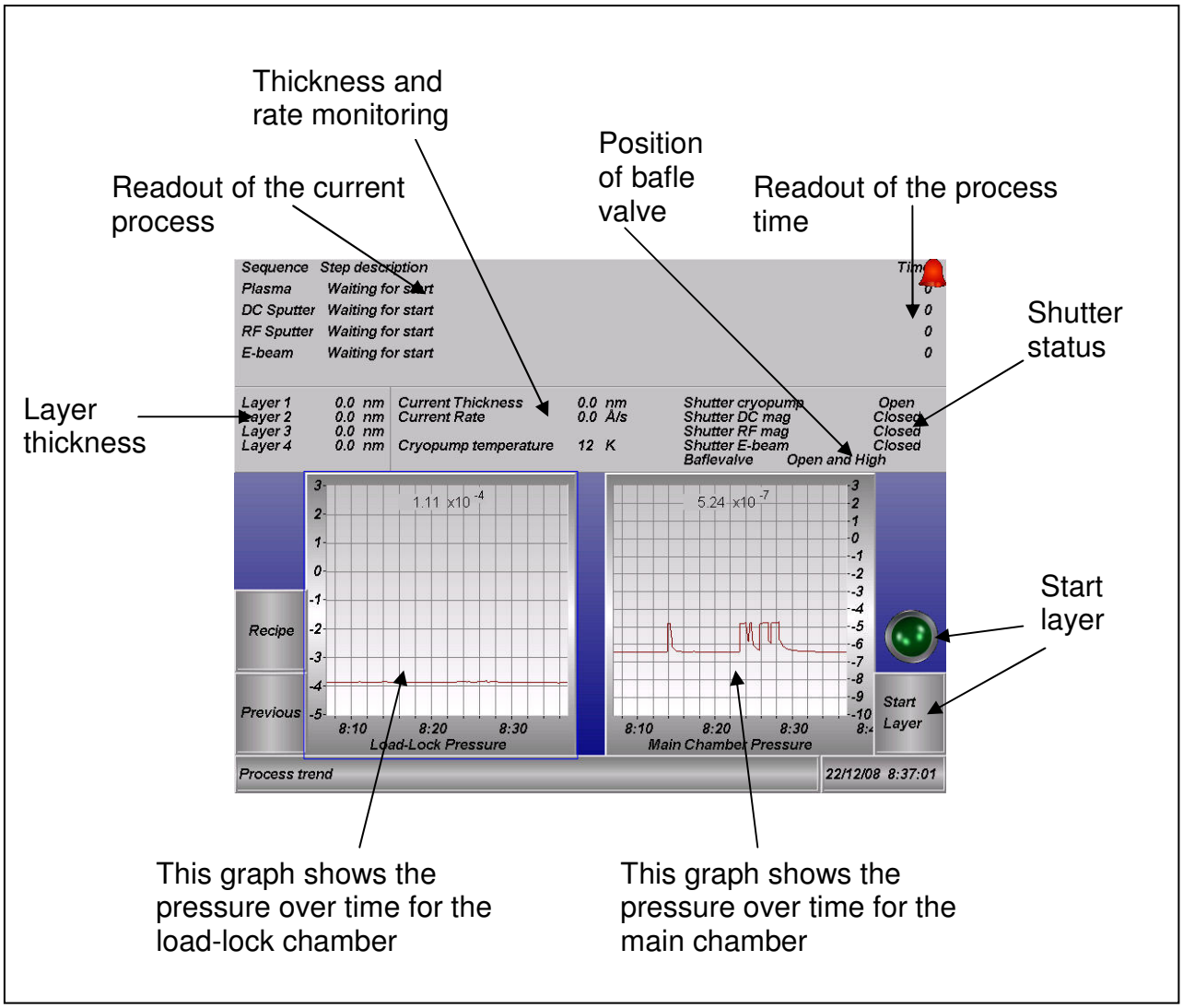

Figure 1 Process Trend

Guide to Process trend

The process trend is mainly used as an info screen. In the top of the screen there is a step description of the process currently active, this tells what the system is doing this instant. On the right side there is a timer which counts for each process step.

The layer thickness is where the final thickness of each layer is stored. These values are all reset when the next process is started.

When the system is ready to start a layer the green bulb lights up, the process will then start when the user push the start layer button. This feature is used to tilt the wafer in the desired direction before starting the coating process.

Cryo regeneration process

The cryo regeneration process is where the user can follow the status of the cryo regeneration.

NOTE
The chamber must not be opened during regeneration process, this will abort the process.

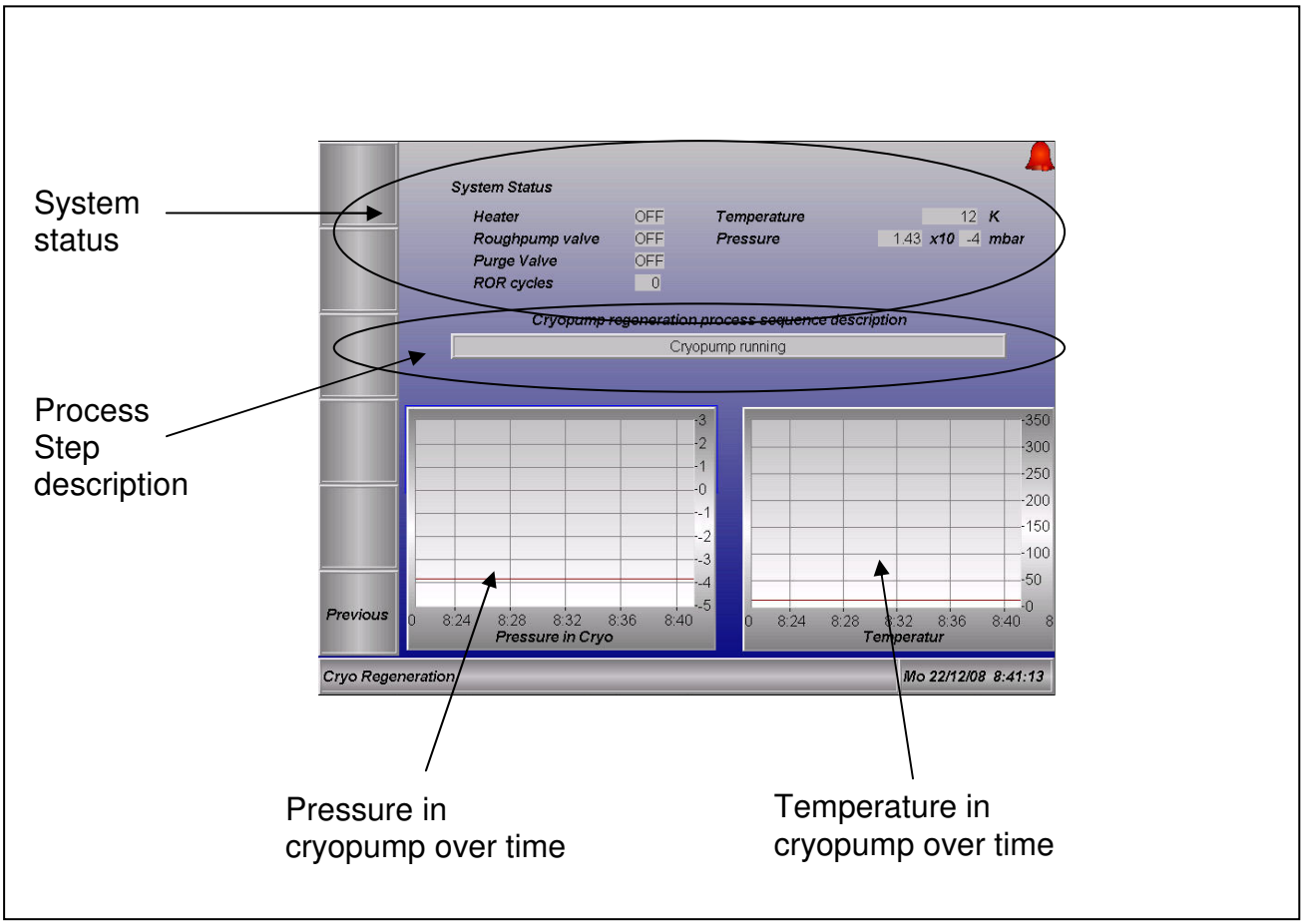

Figure 2 Cryo Regeneration Process

User runs the program following this procedure

1. Go to the “Cryo Regen Recipe” menu
2. Enter the desired data in the recipe and press “Use Recipe”
3. Press “Cryo Regen” button
4. Press “Start/Stop Process” button
5. Cryo pump regeneration program start and can be monitored in the “Cryo Regen Process” menu

For further information regarding the regeneration of the cryo pump refer to the corresponding manual in “Component manuals”.

Recipe

This is where the user can set variable settings that control the process. This is divided in the different processes the machine is capable of doing. The main recipe menu is where the user chooses the specific recipe's wanted. This is shown in Figure 3 Recipe Main Menu.

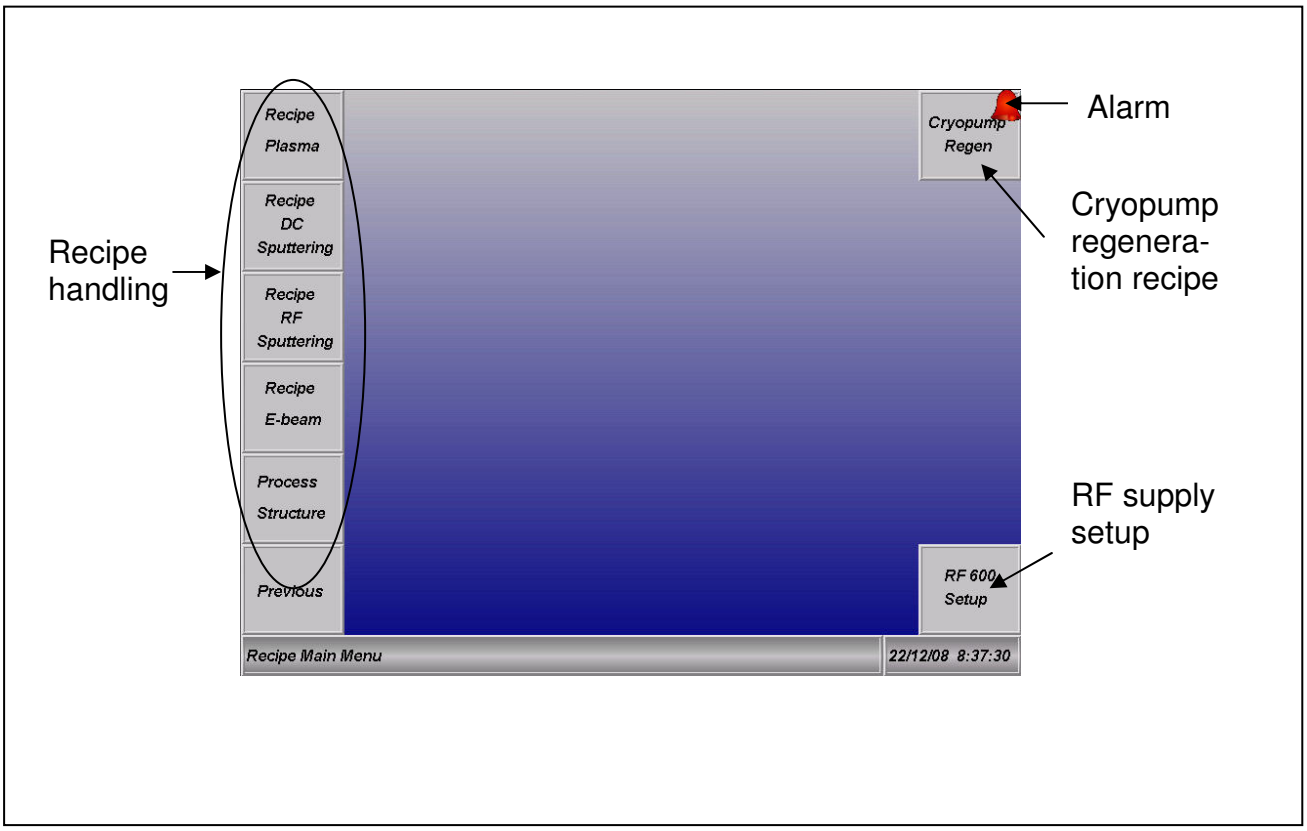

Figure 3 Recipe Main Menu

The different recipes are described in the following.

Recipe Plasma

- Base pressure before plasma cleaning: This is the pressure the load lock will be pumped to before the system starts the plasma cleaning process.
- Ar flow during plasma process: This is the flow of Ar to the load lock during the plasma cleaning process.
- Plasma pregas time: This is the time the system is letting in Ar before it ignites the plasma.
- Plasma cleaning time: This is the time the plasma is on.
- Load-lock pressure before baffle valve opens: This is the pressure the load lock is pumped to before the baffle valve opens to the main chamber.

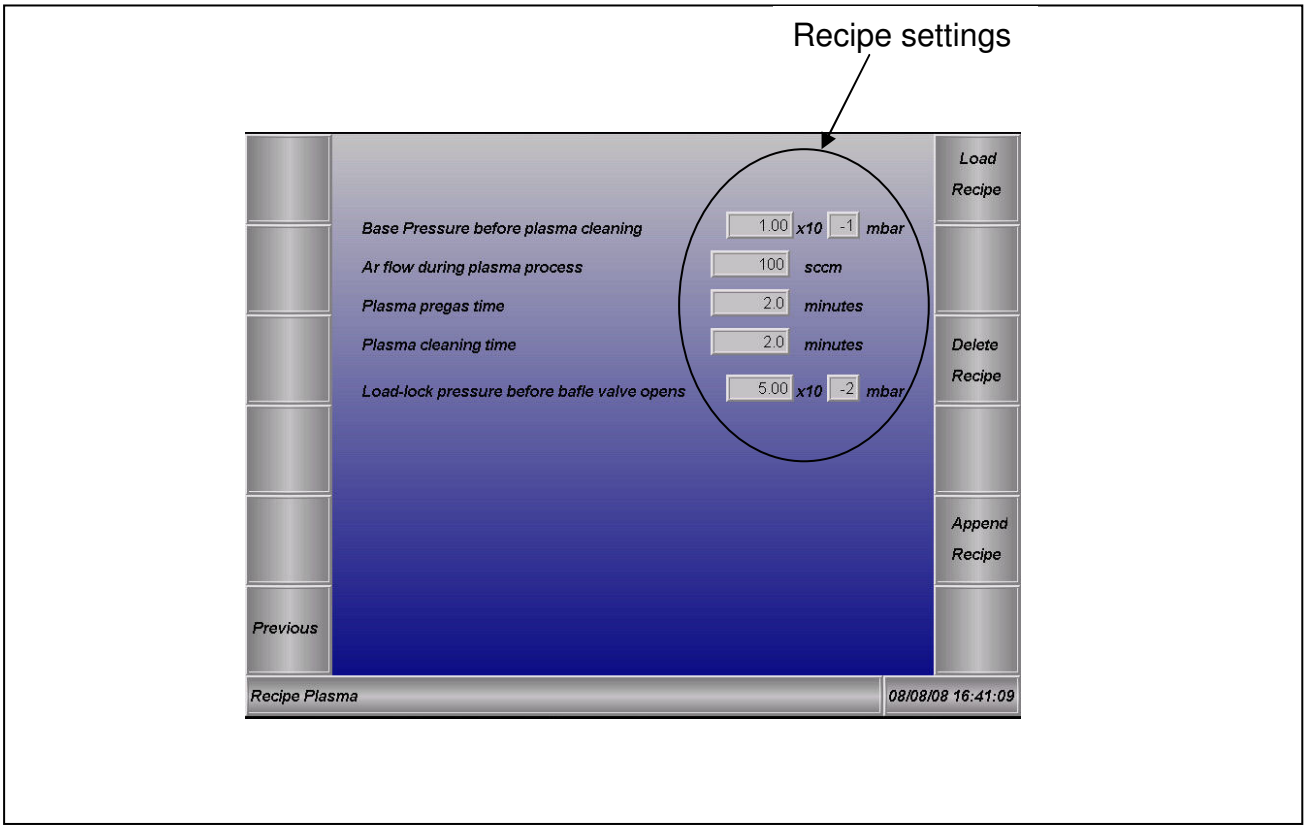

Figure 4 Recipe Plasma

Recipe DC sputter

- Base pressure: This is the pressure the system is pumped to before starting the sputtering process.
- Sputter pressure: This is the pressure where the sputtering is taking place, this is achieved by closing a shutter on the turbo pump and with a flow of Ar in the main chamber.
- Pregas flow: This is a boost for the gas flow at startup. This is used to lower the gas inlet time, if the approximate gas flow is known. If the gas flow is not known, this value should be set to zero.
- Thickness: This is the desired thickness of the layer.
- Rate: This is the rate the sputter will aim to uphold during the sputtering process.
- Start power: The magnetron supply will start up with this power.
- Max power: The magnetron supply will not rise above this power, even if the rate is too low.
- Shutter time: The time from the magnetron supply is on till the shutter opens.
- Tooling factor: This is the tooling factor for XTC3/S sensor 1.
- Z-ratio: The Z-ratio value for the substrate material.
- Density: The density value for the substrate material.

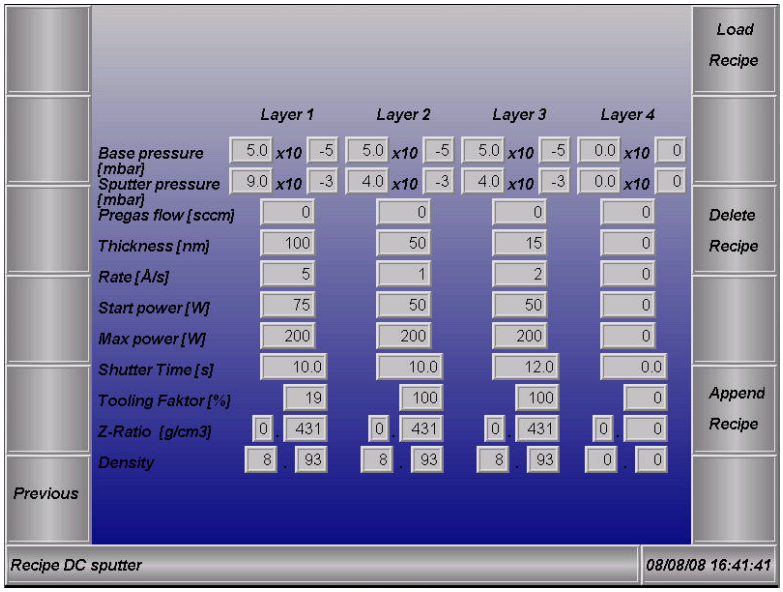

Figure 5 Recipe DC Sputter

Recipe RF sputter

- Base pressure: This is the pressure the system is pumped to before starting the sputtering process.
- Ignition pressure: This is the pressure the system will go to too ignite the RF plasma. This is achieved by closing a shutter on the turbo pump and with a flow of Ar in the main chamber.
- Sputter pressure: After ignition of the plasma the system will go to this pressure for the rest of the sputtering process.
- Percent N2: This is the percentage of N2 (relative to Ar) when reactive sputtering is wanted.
- Thickness: This is the desired thickness of the layer.
- Rate: This is the rate the sputter will aim to uphold during the sputtering process.
- Tooling factor: This is the tooling factor for XTC3/S sensor 2.
- Z-ratio: The Z-ratio value for the substrate material.
- Density: The density value for the substrate material.

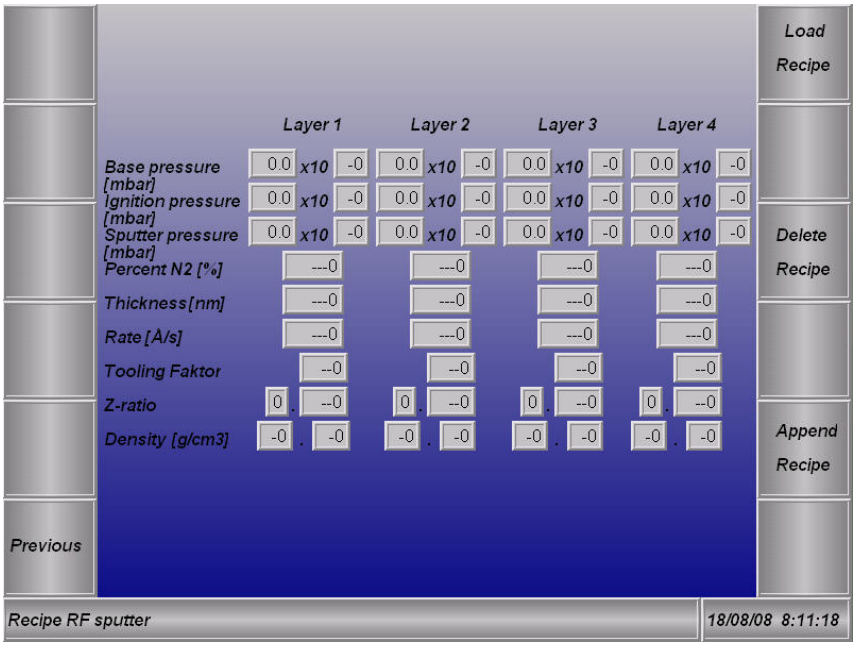

Figure 6 Recipe RF sputter

Recipe E-beam

- Base pressure: This is the pressure the system is pumped to before starting the e-beam process.
- Thickness: This is the desired thickness of the layer.
- Rate: This is the rate the e-beam will aim to uphold during the evaporation process.
- Pocket No: Chooses the pocket number.
- Tooling factor: This is the tooling factor for XTC3/S sensor 1.
- Z-ratio: The Z-ratio value for the substrate material.
- Density: The density value for the substrate material.
- Ignition emission: The max emission current during startup of the e-beam.
- High voltage setpoint: The value for the high voltage.

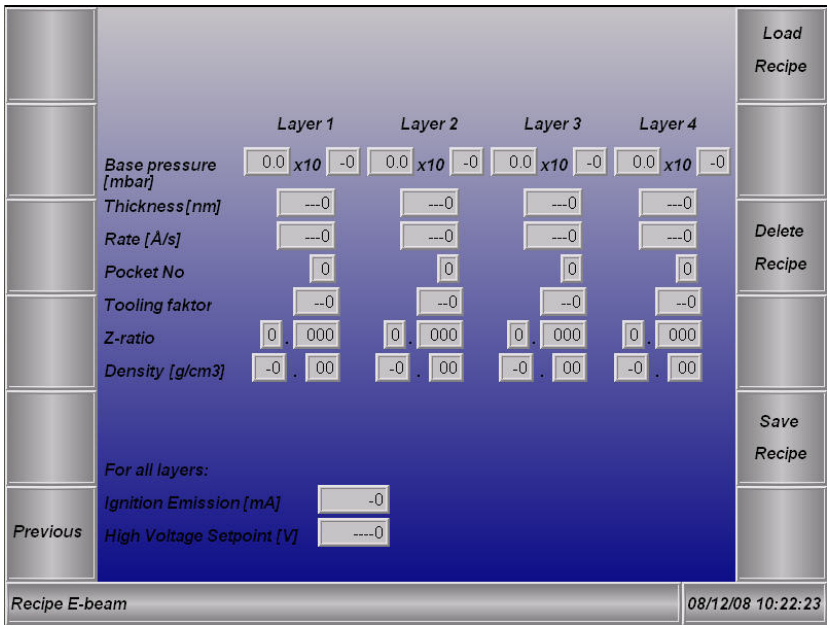

Figure 7 Recipe Ebeam

Recipe process structure

This is where the layer structure is set up. The layers are indicated with an on/off status. Only one evaporation method can be active in each layer. When the desired process structure is set up, the button “use recipe” must be pushed to activate the setup.

Figure 8 Recipe Process Structure

Cryo regeneration recipe

In the cryo regeneration recipe the user sets up the data for used when regenerating the cryo pump.

- Heat up temperature on stage 2: This is the temperature the cryo pump will warm up to using heating elements and gas.
- Pump down pressure: This is the pressure the cryo pump is pumped to before starting the rate-of-rise test.
- Time to measure pressure increase: This is the time without any pumping on the cryo pump, rate-of-rise time.
- Max allowed pressure increase: This is the maximum pressure of the cryo pump for approval after the rate-of-rise.
- Pump down pressure before turning on: This is the pressure the cryo pump is pumped to when the rate-of-rise is approved and the cryo pump will start cool down.
- Cool down temperature: The final temperature before the machine can be used to other processes.
- Max ROR cycles: This is the maximum allowed number of rate-of-rise circles. If more cycles than the max number is reached this regeneration process will stop.

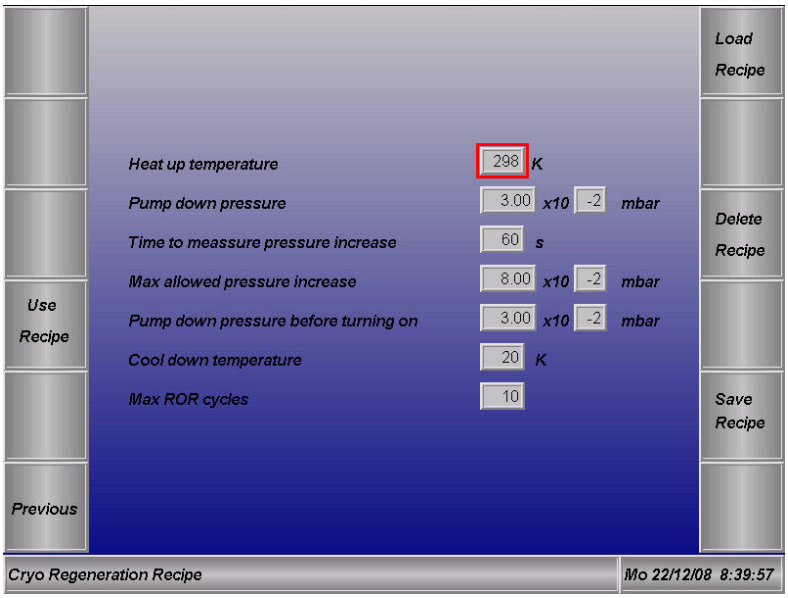

Figure 9 Cryo Regeneration Recipe

Recipe RF600 Setup

This setup screen is used for profibus settings and is only to be operated by qualified personal. If changes is made in the setup of the RF plasma these settings must be entered in this menu for the automatic RF sputtering process to work. Refer to the manual for the PFG RF 600 in component manuals. Any changes here is adapted directly when entered.

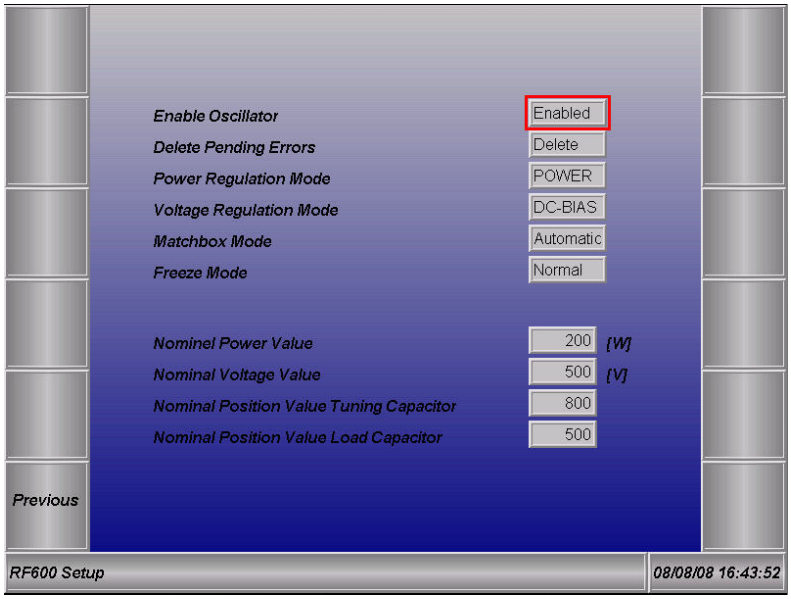

Figure 10 RF600 Setup

Save/Load/Delete Recipe

The function Save recipe adds signals and their values from the current screen to an existing recipe in the terminal. This entails that the operator can save signals and their values from different screens in one joint recipe.

The function Load recipe loads the recipe in all the screens where data have been appended.

Delete recipe deletes the recipes data in all the screens where data have been appended.

Alarms

This section shows alarms on system. The alarms is described in the display, following alarms is possible:

- Wrong flow in cryo pump compressor cooling water.
  - This alarm is active if the water flow on the cryo pump compressor is out of range. If so the pump will start to shut down. When water flow is acceptable again the cryo pump will start up again. When this alarm is active there will be a beeping acoustic alarm.
- No cooling water on e-beam, process can not start.
  - When the cooling water flow is to low on the e-beam this alarm is high. When this alarm is active there will be a constant acoustic alarm.
- Error in compressed air system, process can not start.
  - This alarm is high when no compressed air is on the system.
- Interlock error on MP1 supply.
  - Refer to the manual for the MP1 supply.
- High temperature on MP1.
  - Refer to the manual for the MP1 supply.
- Power failure on MP1.
  - Refer to the manual for the MP1 supply.
- Communication error on□ MP1
  - Refer to the manual for the MP1 supply.
- Internal communication error on MP1.
  - Refer to the manual for the MP1 supply.
- Error in RF600 supply, error number #.
  - Refer to the manual for the RF600 supply
- Safetyswitch activated, reset to restore circuit.
  - This is high when the emergency button on the front is pushed.
- Overload E-beam, contactor switched off.
  - Reset the contactor in the electrical panel on the back of the control rack. Refer to the electrical diagram.
- Overload MP1, contactor switched off.
  - Reset the contactor in the electrical panel on the back of the control rack. Refer to the electrical diagram.
- Overload RF600, contactor switched off.
  - Reset the contactor in the electrical panel on the back of the control rack. Refer to the electrical diagram.
- Overload Rough pump, contactor switched off.
  - Reset the contactor in the electrical panel on the back of the control rack. Refer to the electrical diagram.
- Overload Cryo pump, contactor switched off.
  - Reset the contactor in the electrical panel on the back of the control rack. Refer to the electrical diagram.
- Overload Plasma supply, contactor switched off.
  - Reset the contactor in the electrical panel on the back of the control rack. Refer to the electrical diagram.

Figure 11 Alarms

Manual control

Here the user can operate the machine in manual mode

WARNING

The manual control is only to be operated by administrator. Only if the machine fails or stalls the manual control should be used to restore the machine to its zero state. It is not advised to run the machine in manual control unless necessary.

In the manual control there are two columns representing the state of the machine. The left column represent the current setting of the machine. The right column is where the user can manually alter the settings of the machine, this requires the machine is changed to manual mode.

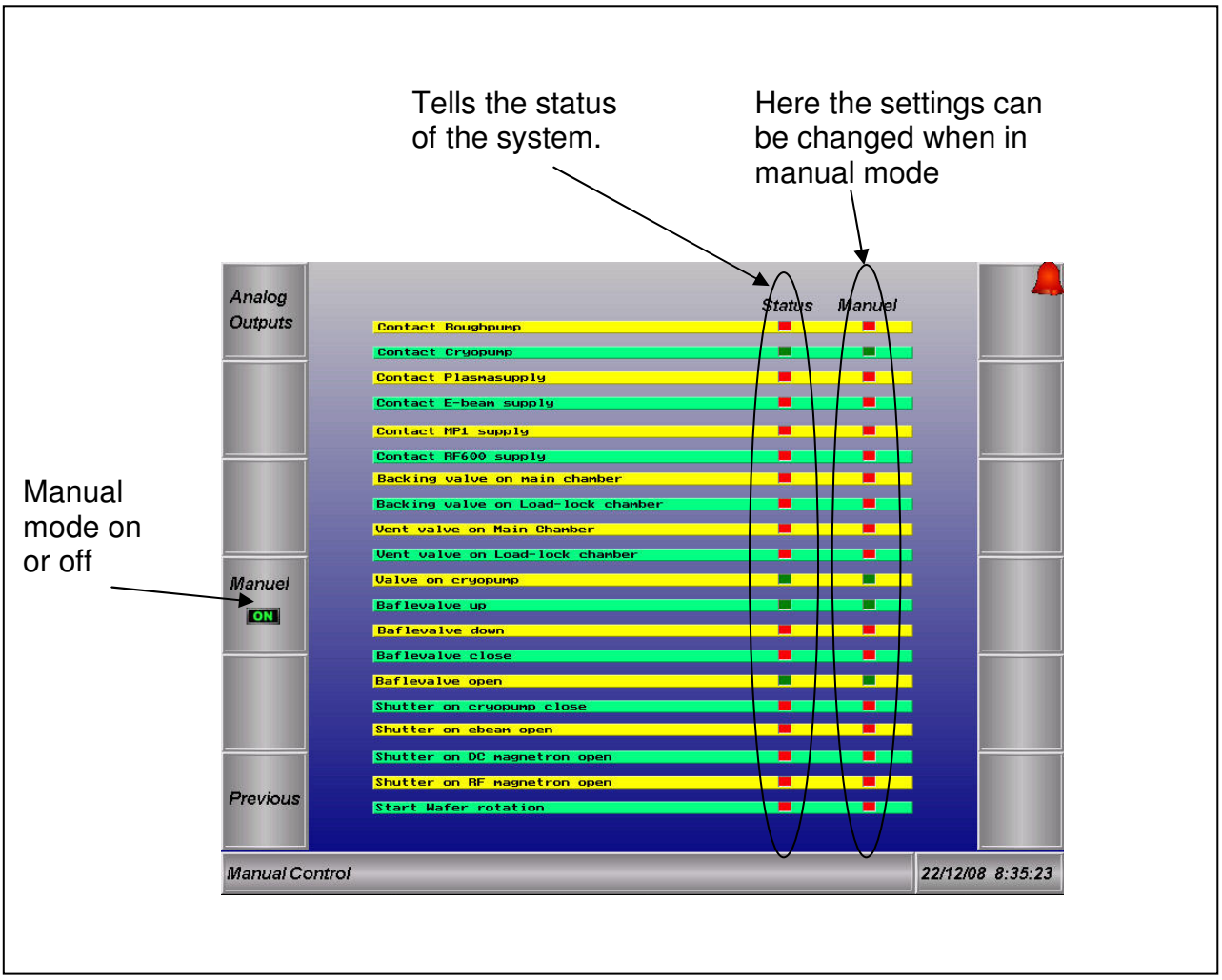

Figure 12 Manual Control

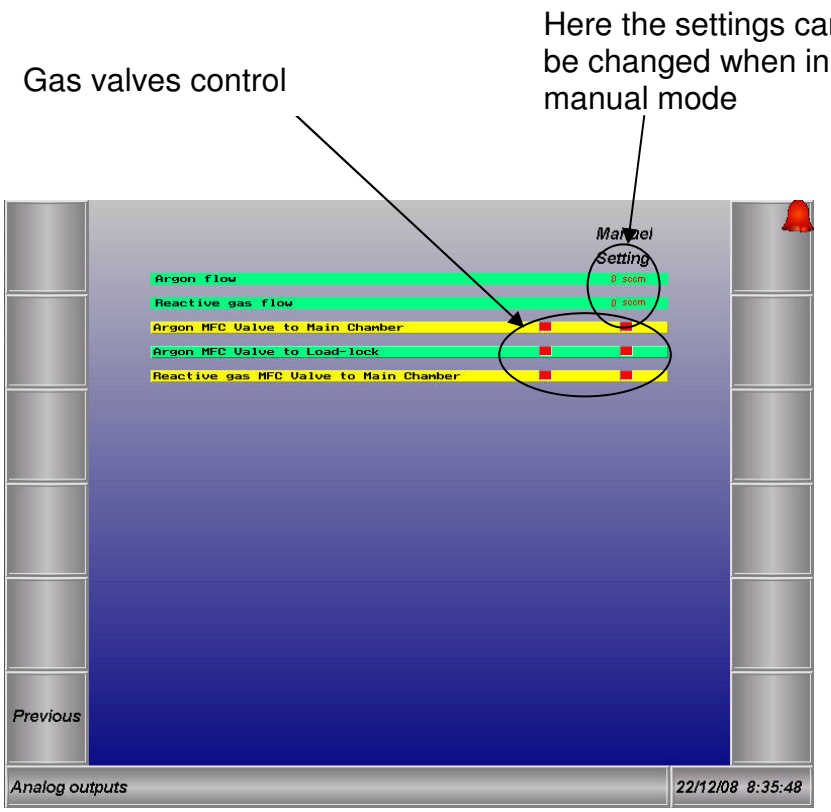

Figure 13 Manual Control Analogue Output

When running the machine in manual mode all components have to be operated manually. The manual operation of the e-beam power supply is written below, for the rest of the components (MP1 magnetron power supply, RF600 power supply, XTC3/S thickness monitor, Supersweep 64) refer to the respective manuals.

E-Beam control interface guide

This interface is used to communicate with the e-beam power supply CV-6SLX when running the e-beam in manual mode. It is where the user can set the high voltage and the emission current. A description of the functionality is given in Figure 14 E-beam Control Interface.

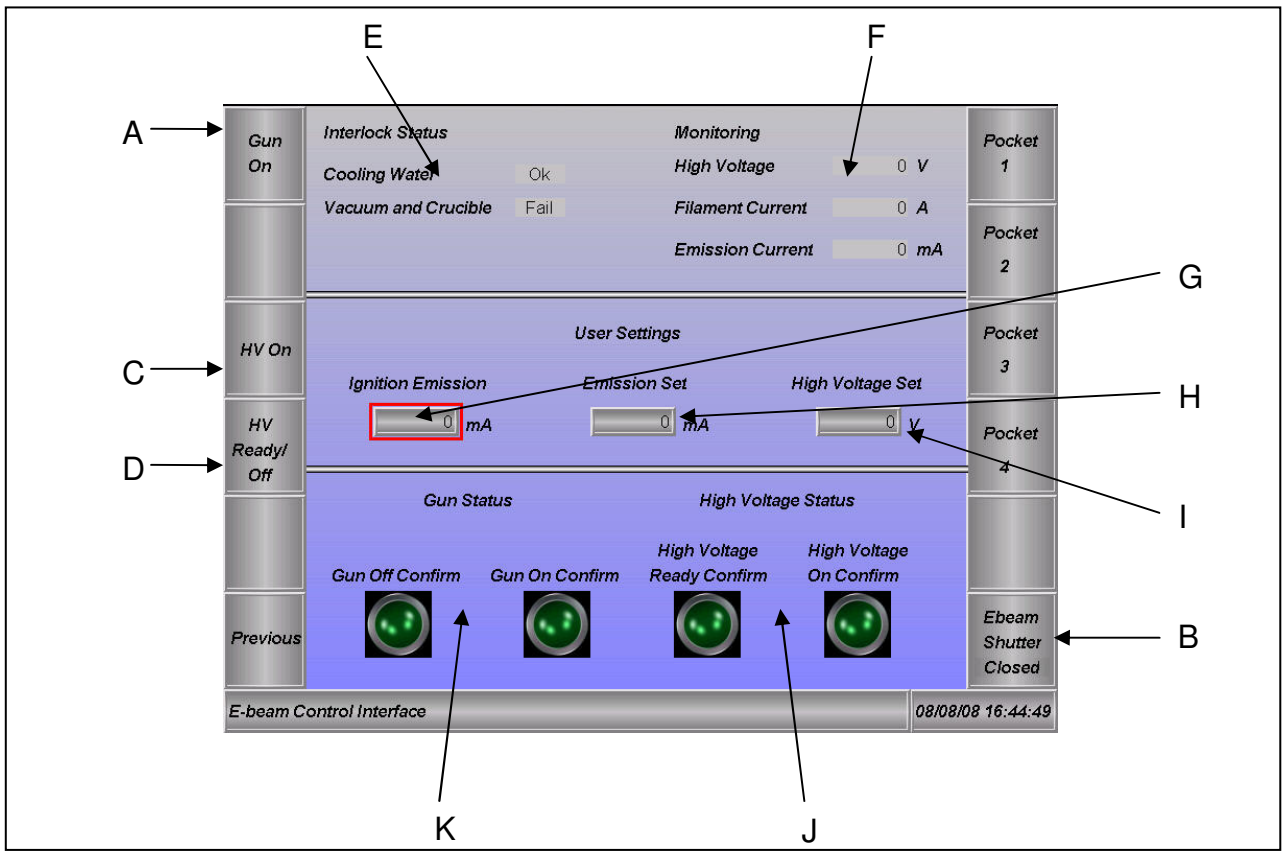

Figure 14 E-beam Control Interface

A: Turns on the e-beam gun, filament- and emission current will rise.
B: E-beam shutter control
C: Turns on the high voltage
D: When high voltage is off it turns the high voltage to ready state, needed to turn the high voltage on. Also turns off the high voltage.
E: This is where status of the interlock is shown.

Cooling water: States ok when flow is ok in e-beam
Vacuum and crucible: states ok when vacuum is low enough and the crucible is positioned correct (fail if positioned between two crucibles). Also the sweeper interlock must be ok or this will fail.

F: This is readout of the CV-6SLX supply
G: Ignition emission is a user setting (max 25mA). It is the start emission current.
H: Emission set is a user setting (max 600mA). The emission will ramp up from ignition emission to emission set when gun is turned on.
I: High voltage set is a user setting (0-10000 V).

J: High voltage status shows the status of the high voltage.
K: Gun status shows if the gun is on or off.

Remark: The crucible select is a one-push button when the main chamber is pumped down. When the main chamber is open the crucible select is a push-and-hold button. If the system is pumped down with a position between two crucibles there will be an interlock fail.

Short guide to start the power supply
This is a step by step description example to start up the e-beam power supply. For further information refer to the CV-6SLX manual.

1. Make sure the interlocks are reading “Ok”
2. Input a high voltage set value
3. Input a ignition emission value
4. Input a emission set value
5. Push the “HV Ready/Off” button
6. Push the “HV On” button for 3 seconds to turn high voltage on
7. Push the “Gun On” button for 3 seconds to turn the gun on and start evaporation

Notice
When running the e-beam the interlock on the sweeper must not be active, this will turn the gun off.

Short guide to shut down the power supply
This is a step by step description example to shut down the e-beam power supply. For further information refer to the CV-6SL manual.

1. Push the “HV Ready/Off” button to turn of the high voltage
2. Wait till the high voltage monitor goes to zero

Running example

A typical run is in the following order

1. Setup the data in the recipe menu, data examples are given below
2. Make sure pumps are running
3. Choose “Coating process”
4. Choose “Process Start/stop”
5. Close the load-lock chamber
6. Chamber is pumping load-lock down and executing chosen recipes

When running an automatic cycle, the following list is what has to be manually adjusted:

- The wafer holder tilted position is to be adjusted when the “start layer” bulb lights up.
- The “start layer” button is to be pressed when ready.
- The supersweep 64 sweep enable button is to be activated if sweeping is wanted when running an e-beam. It’s recommended not to enable sweep when e-beam is not running.
- At any time during an automatic process the “start/stop process” button can be pushed to stop the process.

Recipe example, plasma

- Base pressure before plasma cleaning = $5{,}00\text{x}10^{-2}$ mbar
- Ar flow during plasma process = 20 sccm
- Plasma pregas time = 1 min
- Plasma cleaning time = 1 min
- Load-lock pressure before baffle valve opens = $5{,}00\text{x}10^{-2}$ mbar

Recipe example, DC sputtering

- Base pressure = $1{,}00\text{x}10^{-6}$ mbar
- Sputter pressure = $4{,}00\text{x}10^{-3}$ mbar
- Pregas flow =10 sccm
- Thickness = 50 nm
- Rate = 3 Å/s
- Start power = 100 W
- Max power = 1000 W
- Shutter time = 1 min
- Tooling factor = 20 %
- Z-ratio = material constant
- Density = material constant

Recipe example, RF sputtering

- Base pressure = $1{,}00\text{x}10^{-6}$ mbar
- Ignition pressure = $1{,}00\text{x}10^{-2}$ mbar
- Sputter pressure = $6{,}00\text{x}10^{-3}$ mbar
- Percent N2 = Reactive process only

- Thickness = 50 nm
- Rate = 3 Å/s
- Tooling factor = 20 %
- Z-ratio = material constant
- Density = material constant

Recipe example, E-beam

- Basic pressure = $5{,}00x10^{-7}$ mbar
- Thickness = 50 nm
- Rate = 3 Å/s
- Pocket No = 1
- Tooling factor = 77 %
- Z-ratio = material constant
- Density = material constant
- Ignition emission = 25 mA
- High voltage setpoint = 7000 V

Recipe example, Cryo Regen

- Heat up temperature = 300 K
- Pump down pressure = $3{,}00x10^{-2}$ mbar
- Time to measure pressure increase = 60 s
- Max allowed pressure increase = $8{,}00x10^{-2}$ mbar
- Pump down pressure before turning on = $3{,}00x10^{-2}$ mbar
- Cool down temperature = 20 K
- Max ROR cycles = 10

Recipe RF600 setup on delivery

- Enable oscillator = Enabled
- Delete pending errors = Delete
- Power regulation mode = POWER
- Voltage regulation mode = DC-BIAS
- Matchbox mode = Automatic
- Freeze mode = Normal
- Nominel power value = 100 W
- Nominel voltage value = 1000 V
- Nominel position value tuning capacitor = 800
- Nominel position value load capacitor = 440

Troubleshooting

If the system fails or stalls in a process and can not be reset by pressing the “Process Start/Stop” button then the system must be reset in manual control mode.

The following procedure is an example how to reset in manual control

1. First in the manual control line activate the ones that are already active, so when the system is switched to manual mode the system is in the same state.
2. First make sure the baflevalve is closed, if it is not close it in the following order
    - Activate the baflevalve close, wait for the baflevalve to be in “high and closed“ position
    - Activate the baflevalve down, wait for the baflevalve to be in “low and closed“ position
3. Close the backing valve on the load-lock chamber
4. Vent the load lock chamber
5. Make sure “Contact rough pump”, “Contact turbo pump”, “Backing valve on turbo pump”, “Baflevalve down” and “Baflevalve close” is the only active settings
6. Switch off manual mode

For errors on the e-beam, CV-6SLX, temescal supersweep, IL800, turbo pump, rough pump, series 910 dualtrans transducer or series 999 quattro multi-sensor transducer refer to the corresponding manuals.