

## 1.1 System description

This multiplex tool is a manual loadlock, HF inductively coupled plasma (ICP) etch system, designed for research and development and small scale production. It has been designed for deep Si trench etching of either a single 100 mm (4 in.) wafer.

### 1.1.1 System configuration

The system consists of a combined ICP electronics, loadlock (universal loadlock assembly) and wafer loader (wafer carriage assembly) unit, and a process chamber. Other major components of the system not shown in the illustration include the prime power cabinet, RF stack, remote gas box, de-ionised water chiller.

The system is let into an interface panel in the clean room wall with the combined ICP electronics, loadlock and wafer loader accommodated in the clean area and the process chamber and other components in the services area.

A general view of the wafer handling and processing part of the system is shown in Figure 1.1, Figure 1.2 and Figure 1.3, with a plan view of the installation shown in Figure 1.4

The process chamber is configured for deep Si trench etching. The plasma is inductively coupled at 13.56 MHz via the matching unit and coil assembly into an alumina chamber. This provides a high density plasma capable of operating in a very wide process range. Independent energy control is provided by 13.56 MHz RF biasing of the electrode via automatic power control and impedance matching.

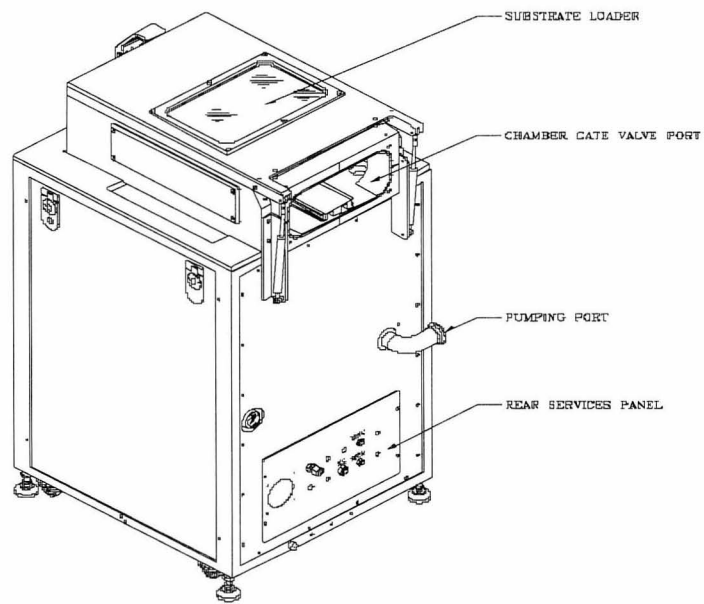
The system is designed for maximum process flexibility and reproducibility. Process gas is introduced to the chamber through the upper cover assembly. The wafers are placed on the electrode assembly which is powered at 13.56 MHz. Temperature control of the wafer platen which is required for certain processes is achieved using a recirculating de-ionised water system.

The chamber has been designed to the highest vacuum engineering standards with the number of components kept to a minimum, with particular consideration given to the elimination of virtual leaks. This results in a very stable chamber environment leading to processes of the highest quality.

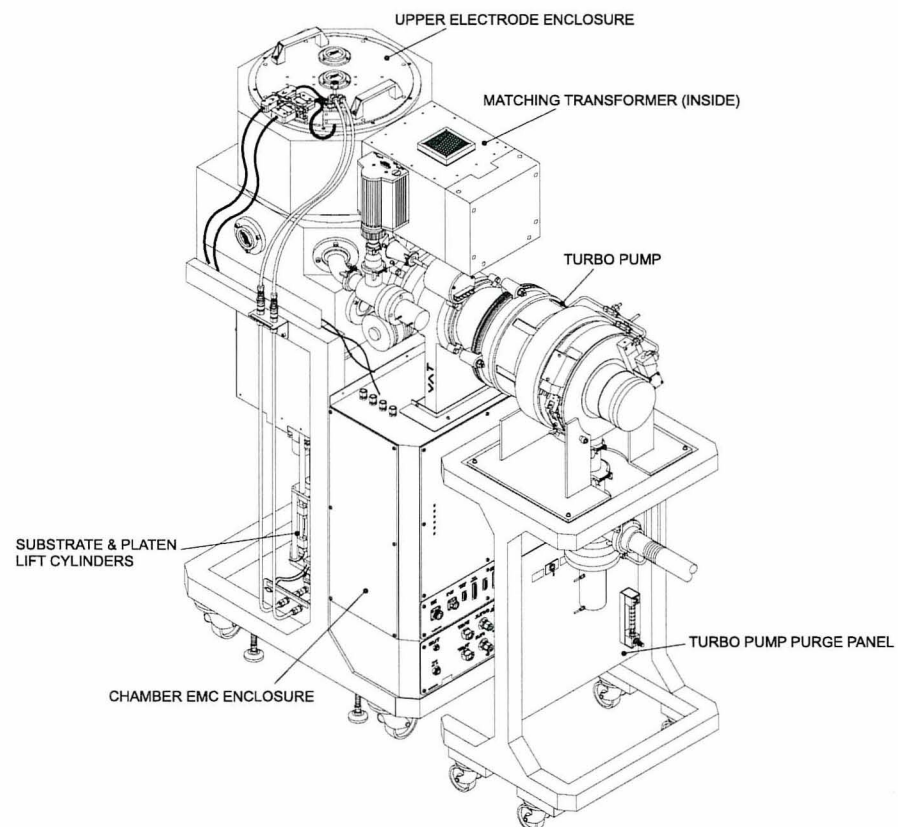
The aluminium loadlock has a transparent hinged lid that allows easy access for loading/unloading of the wafer carrier.

After loading of the wafer into the loadlock, the system automatically carries out pump down, leak check and transfer of the wafer into the process chamber via the carriage assembly, after which the process is started.

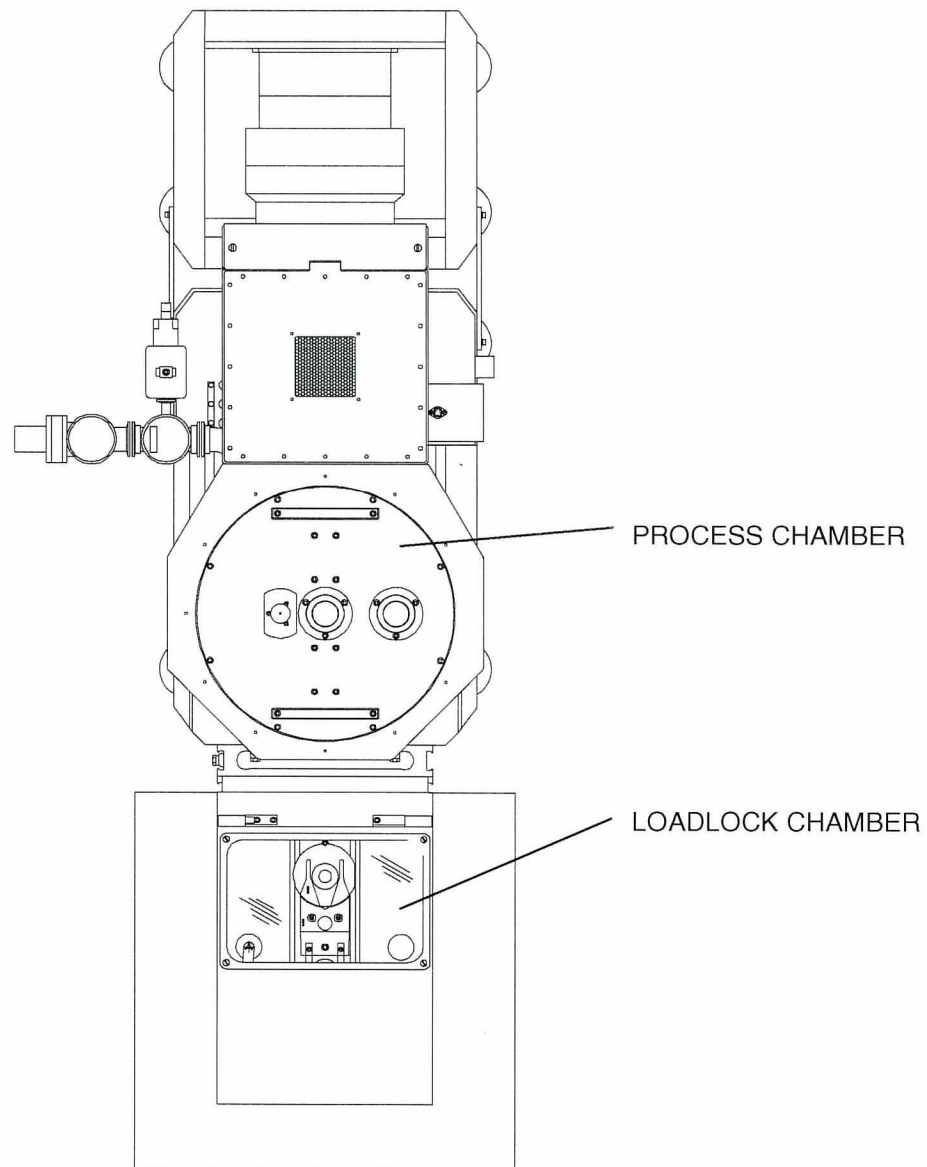
System control is via a standard PC which provides fully automatic and user friendly operation. A colour monitor displays process information and mimic displays, allowing the system to be easily operated and continuously monitored. Process recipes may be downloaded to hard or floppy disk, allowing secure storage of unlimited numbers of recipes.



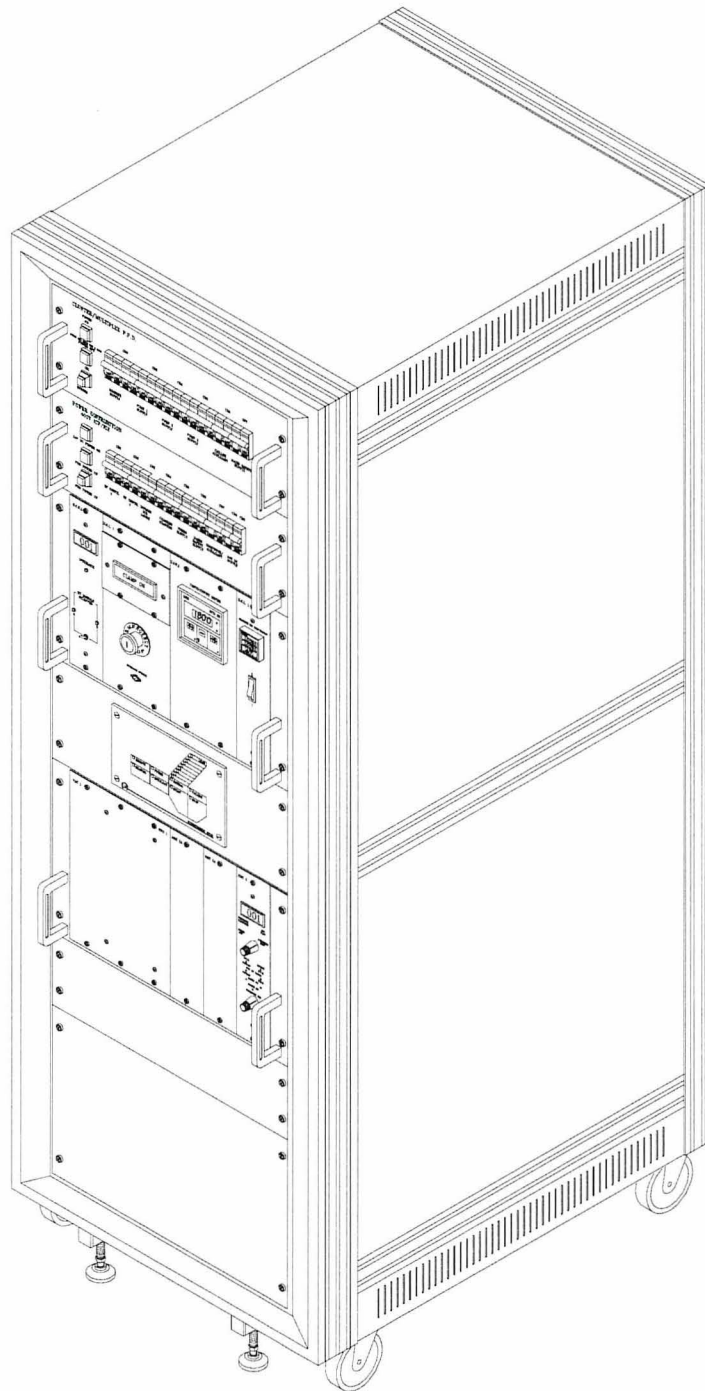
**Figure 1.2 Loadlock assembly**



**Figure 1.3 Process chamber assembly**



**Figure 1.4 System plan view**





## 1.2 System components

The major components of the system are:

- Computer control system
- Prime Power Distribution Cabinet combined with the process chamber electronics
- Loadlock cabinet
- Loadlock and wafer loader
- Process chamber
- RF stack
- Remote gas box
- De-ionised water heater/chiller

### 1.2.1 Computer control system

The standalone computer control system is based on an IBM compatible PC with a VGA colour monitor, keyboard and mouse. It runs the system control software in a Windows environment.

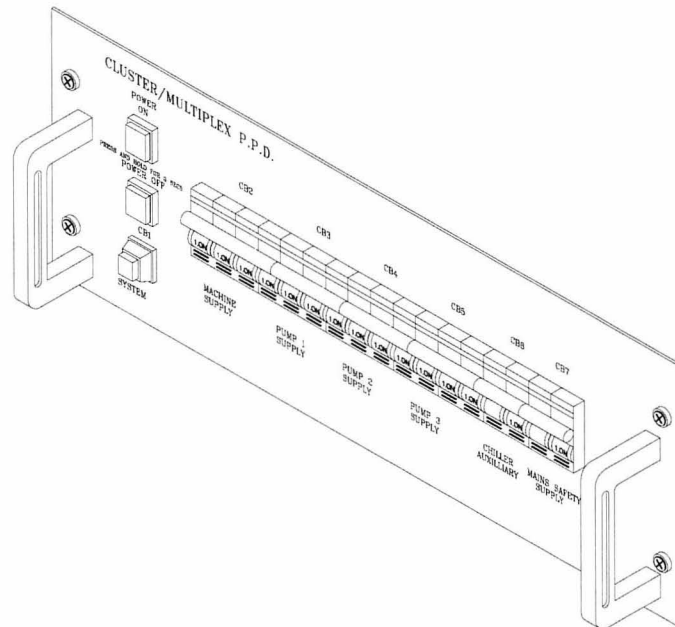
### 1.2.2 Process chamber electronics

The process chamber electronics are housed in the remote free standing cabinet. The cabinet consists of:

- Prime power distribution drawer
- Power distribution panel
- Electrostatic chuck unit (if applicable) - ECU1
- Interlock display module
- Conductivity monitor (DI water) - DIW1
- Heater chamber lid module (HCL1)
- Ion gauge controller
- Electro-Magnetic Compatibility module (EMC), comprising:
  - Vacuum control (VAC3)
  - Automatic matching control modules (2 off) - AMC1A
  - Helium backside cooling module (HBC1)

### 1.2.2.1 Prime power distribution (PPD) drawer

The Prime power distribution drawer, which is shown in Figure 1.6, controls and distributes power to the whole system.



**Figure 1.6 Prime power distribution (PPD) drawer**

The following table contains details of the prime power distribution drawer components along with their description and function.

**Table 1.1 PPD component description and function**

| Component               | Description                       | Function                                                                                                                                   |
|-------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| POWER ON                | Green pushbutton                  | Switches power ON provided the safety interlocks have not been activated.                                                                  |
| POWER OFF               | Blue pushbutton                   | Switches power OFF.                                                                                                                        |
| CB1 - 24V SAFETY SUPPLY | Miniature thermal circuit breaker | Protects the 24V d.c. safety supply.<br>Shows the current rating when IN (not activated), and the legend PRESS RESET when OUT (activated). |
| CB2 - MACHINE SUPPLY    | Four gang circuit breaker         | Protects mains supply.                                                                                                                     |

| Component                   | Description                | Function                                                         |
|-----------------------------|----------------------------|------------------------------------------------------------------|
| CB3 - PUMP 1 SUPPLY         | Three gang circuit breaker | Protects mains supply to the chamber rotary pump.                |
| CB4 - PUMP 2 SUPPLY         | Three gang circuit breaker | Not Used                                                         |
| CB5 - PUMP 3 SUPPLY         | Three gang circuit breaker | Protects mains supply to the loadlock pump.                      |
| CB6 - CHILLER/AUXILIARY     | Two gang circuit breaker   | Protects mains supply to external chiller.                       |
| CB7 - MACHINE SAFETY SUPPLY | Two gang circuit breaker   | Protects the mains input to the 24V d.c. safety supply rectifier |

### 1.2.2.2 Power distribution panel

The power distribution panel located below the prime power distribution drawer, supplies mains power to components associated with the process chamber.

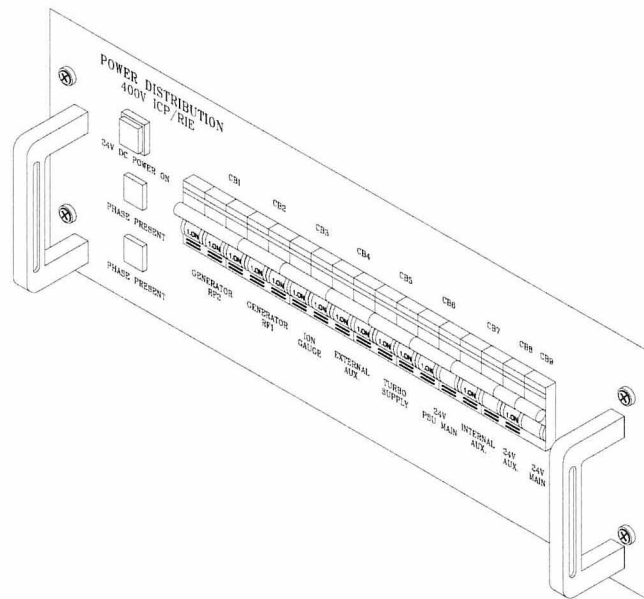


Figure 1.7 Power distribution panel

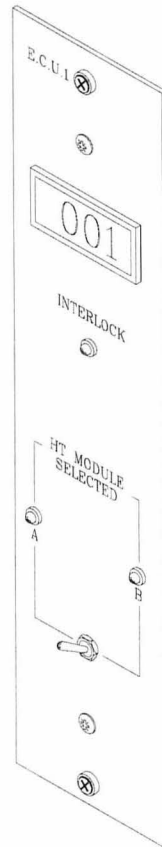
Table 1.2 contains details of the power distribution panel components along with their description and function.

**Table 1.2 Power distribution panel, component description and function**

| Component                  | Description                  | Function                                                                                                                |
|----------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 24V DC POWER ON            | Illuminated amber pushbutton | Switches power ON provided safety interlocks have not been activated. Also 24V d.c. supply (and mains phase 1) present. |
| PHASE PRESENT              | Green neon indicator         | Indicates mains phase 2 is present.                                                                                     |
| PHASE PRESENT              | Green neon indicator         | Indicates mains phase 3 is present.                                                                                     |
| CB1 - RF GENERATOR (GEN) 2 | Three gang circuit breaker   | Protects mains supply to the RF generator 2.                                                                            |
| CB1 - RF GENERATOR (GEN) 1 | Two gang circuit breaker     | Protects mains supply to the coil RF generator 1.                                                                       |
| CB3 - INFICON ION GAUGE    | Two gang circuit breaker     | Not used.                                                                                                               |
| CB4 – EXTERNAL AUX         | Two gang circuit breaker     | Protects mains supply to chamber wall heaters.                                                                          |
| CB5 - TURBO SUPPLY         | Two gang circuit breaker     | Protects mains supply to process chamber turbo pump.                                                                    |
| CB6 – 24V PSU MAIN         | Two gang circuit breaker     | Protects mains supply to 24V d.c. power supply.                                                                         |
| CB7 – INTERNAL AUX         | Two gang circuit breaker     | Protects mains supply to process chamber and auxiliary equipment.                                                       |
| CB8 - 24V AUX              | Two gang circuit breaker     | Protects switched 24V d.c. supply to: gas pod modules                                                                   |
| CB9 - 24V DC SUPPLY        | Two gang circuit breaker     | Protects unswitched 24V d.c. supply to: electronic modules                                                              |

### 1.2.2.3 Electrostatic chuck unit - ECU1 (if applicable)

The ECU1 module, shown in Figure 1.8, controls the high voltage d.c. supply to the electrostatic chuck.



**Figure 1.8 ECU1 module**

The ECU1 module comprises the following controls and indicators:

**Table 1.3 ECU1 module, controls and indicators**

| Component | Description                      | Function                                                           |
|-----------|----------------------------------|--------------------------------------------------------------------|
|           | Display unit                     | Displays value of parameter selected by two position lever switch. |
| INTERLOCK | Green light emitting diode (LED) | Indicates the ECU interlock has been activated.                    |
| A-B       | Two position lever switch        | Selects parameter for display.                                     |

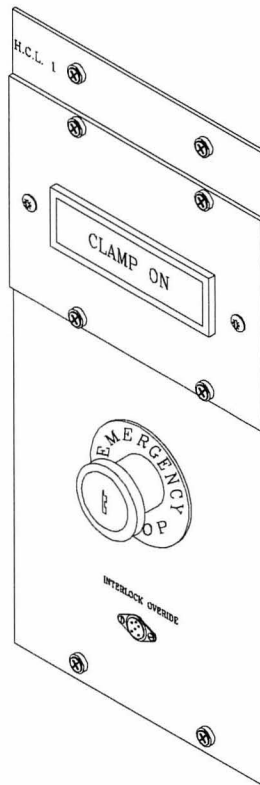


#### 1.2.2.4 Interlock display module

The interlock display module shows interlock fault messages whenever an interlock circuit is interrupted. The two interlock that are monitored are:

- +24V d.c. supply for the gas box pneumatic solenoids
- RF interlock chain which prevents RF power being turned ON if the chain is broken

The display blinks whenever an interlock circuit is broken; and indicates which chain by displaying 24V/GAS or RF working normally.



**Figure 1.9 Interlock display module**

The interlock display module has the following controls and indicators:

**Table 1.4 Interlock display module, controls and indicators**

| Component         | Description               | Function                              |
|-------------------|---------------------------|---------------------------------------|
| INTERLOCK DISPLAY | Display unit              | Display interlock error messages.     |
| EMERGENCY STOP    | Emergency STOP button     | Shuts the whole system down.          |
|                   | 4-pin switched DIN socket | For connection of HiVAC break-in box. |

#### 1.2.2.4.1 24V gas interlock chain

The 24V d.c. supply for the pneumatic solenoids in the gas box, which is displayed as 24V/GAS, comprises the sensors and displayed messages listed in Table 1.5.

**Table 1.5 24V gas interlock chain messages**

| Sensor               | Message  |
|----------------------|----------|
| Gate shut switch     | GATE OPN |
| Purge unit           | N2 PURGE |
| Over pressure sensor | OVR PRES |
| High vacuum valve    | HVAC VAL |
| Compressed air       | COMP AIR |

**Note:** Although the compressed air interlock is not normally part of this interlock chain, it is sensed and displayed should a fault occur. However, the HVAC VAL fault is usually displayed as the chamber high vacuum valve is shut by the process computer whenever a compressed air fault occurs.

#### 1.2.2.4.2 RF interlock chain

Eight sensor inputs are provided for the RF interlock chain. Four of the inputs are provided for safety interlocks as shown in Table 1.6. The other four inputs are normally used whenever cooling of the platen or wafer is required. These are displayed in Table 1.7.

**Table 1.6 RF interlock chain messages**

| Sensor               | Message  |
|----------------------|----------|
| Gate shut switch     | GATE OPN |
| Platen matching unit | BOTM MU  |
| Top matching unit    | TOP MU   |
| RF enclosure         | RF ENCL  |

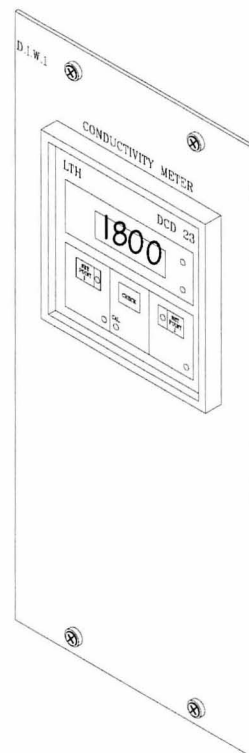
**Table 1.7 Platen and wafer cooling messages**

| Sensor                                        | Message   |
|-----------------------------------------------|-----------|
| Clamp on switch                               | CLAMP ON  |
| Helium back cooling module                    | He COOL   |
| Coolant 1 input for de-ionised water sensor   | COOLANT 1 |
| Coolant 2 input for flowmeter and temperature | COOLANT 2 |

**Note:** Coolant 1 and Coolant 2 inputs are also used for interlocking the TMC1 modules to prevent power being applied to the heaters should a coolant fault occur.

#### 1.2.2.5 Conductivity monitor module - DI water (DIW1)

The DIW1 module monitors the conductivity of the de-ionised water supply and interlocks the application of the RF, if conductivity increases beyond its pre-set value.

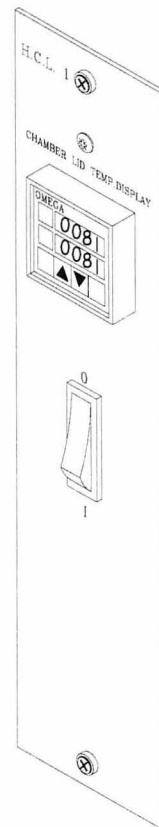


**Figure 1.10 DIW1 module**

The controls and indicators are described in the manufacturers literature.

### 1.2.2.6 Heater chamber lid module - HCL1

The HCL1 module controls the chamber lid temperature, usually set to between 30 and 80 degrees centigrade, for run-to-run uniformity. The chamber lid heater element comprises a thermal runaway trip switch to prevent damage to the chamber lid assembly. The trip switch will become open circuited if the chamber lid temperature exceeds 85 degrees centigrade.



**Figure 1.11 HCL1 module**

The HCL1 module comprises the following controls and indicators:

**Table 1.8 HCL1 module, controls and indicators**

| Component                       | Description                                 | Function                                                                                             |
|---------------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------------|
| CHAMBER LID TEMPERATURE DISPLAY | Temperature display indicator               | Used to set the chamber lid temperature (usually between 30 and 80°C).                               |
| FS1 - 4 AMP I/O                 | Dual operational switch and circuit breaker | ON/OFF switch and circuit breaker to protect the mains supply to the process chamber heater element. |

### 1.2.2.7 Electro-magnetic compatibility module (EMC)

The EMC unit comprises the following modules:

- VAC3
- AMCA1A x 2
- HBC1

#### 1.2.2.7.1 Vacuum control module – VAC3

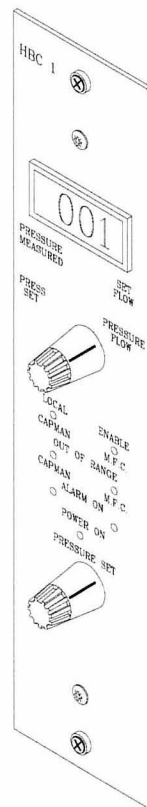
This microprocessor based module controls the process chamber pumping, venting and pressure control.

#### 1.2.2.7.2 Automatic matching control modules - AMC1A

The AMC1A modules (one each for the coil and platen) are used to drive the matching units associated with their respective RF generators.

#### 1.2.2.7.3 Helium backside cooling module - HBC1

The HBC1 module shown in Figure 1.12 controls the wafer helium back cooling system.



**Figure 1.12 HBC1 module**

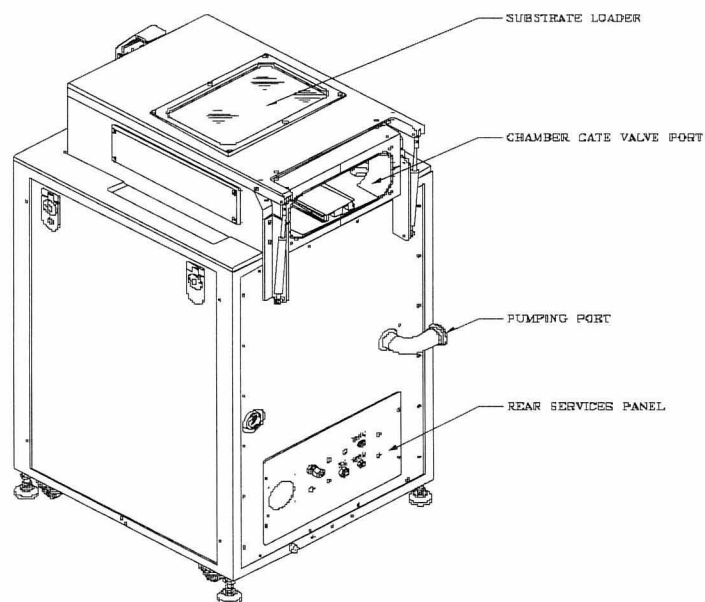
The HBC1 module has the following controls and indicators:



**Table 1.9 HBC1 module, controls and indicators**

| Component                                                            | Description     | Function                                                              |
|----------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------|
|                                                                      | Digital display | Indicates value for parameter selected by function switch.            |
| LOCAL CAPMAN<br>ENABLE MFC                                           | 2 Yellow LED's  | Indicates that the MFC and CapMan gauges are in operation             |
| PRESSURE SET /<br>PRESSURE MEASURED /<br>SET FLOW /<br>MEASURED FLOW | Rotary switch   | Selects parameter to be shown on digital display.                     |
| CAPMAN MFC<br>OUT OF RANGE                                           | Amber LED       | Indicates helium pressure outside pre-set range.                      |
| CAPMAN MFC<br>ALARM ON                                               | Red LED         | Indicates low (alarm level) helium pressure.                          |
| POWER ON                                                             | Green LED       | Indicates HBC module has power applied.                               |
| PRESSURE SET                                                         | Potentiometer   | Used to set pressure on display when PRESSURE SET selected by switch. |

### 1.2.3 Loadlock assembly

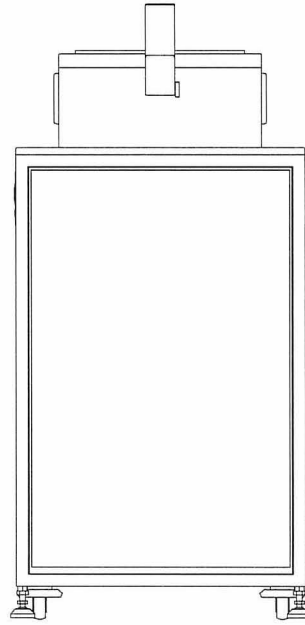


**Figure 1.13 Loadlock assembly (same as Figure 1.2)**

The loadlock assembly comprises an electronics cabinet, the loadlock complete with a linear type wafer loader, and the vacuum pumping system.

## 1.2.3.1 Loadlock electronics cabinet

The loadlock electronics cabinet houses the loadlock control drawer (complete with power supply unit), the pneumatic control drawer which drives the associated loadlock pneumatic components, the system Emergency STOP button and the associated vacuum pumping components. The loadlock, complete with wafer loader, is located on the top of the loadlock electronics cabinet.



**Figure 1.14 Loadlock cabinet units**

### 1.2.3.1.1 Loadlock control drawer

The loadlock control drawer houses the microprocessor based control module. The module controls the sequence of events, including vacuum pumping, for the transfer of wafers between the loadlock and process chamber. This includes the operation the high vacuum pumping valve; the high vacuum gate valve (process chamber gate valve); the process chamber wafer lift mechanism and the process chamber wafer clamping.

### 1.2.3.2 Principle Components of the Carousel Loadlock

- Hinged lid low volume enclosure
- Spatula/transport mechanism
- Position sensors
- Pumping system
- Vacuum Gauging
- Control System
- Hinged lid low volume enclosure

As already stated the loadlock is an aluminium body with a hinged lid that has the minimum possible volume to maximise throughput. A High vacuum slit valve at one end of the loadlock allows entry into the process chamber and ensures that the operator is protected from the toxins in the process chamber.

All the other components either hang off or are housed inside the loadlock.

## **1.2.3.3 Spatula/transport mechanism**

### **1.2.3.3.1 Drive mechanism**

A spatula is mounted onto a harmonic handler system.

An electric motor drives the spatula into the chamber.

A pneumatic mechanism lifts the spatula above the harmonic handler system to allow a second electric motor to rotate the spatula to position the required wafer for placement onto the electrode.

The two motors are controlled by a purpose built drive system that is housed in the electro-pneumatic drawer an encoder feeds back to the system to ensure accurate positioning

Plastic bearings provide a low friction low particulate generating transport mechanism

### **1.2.3.3.2 Position Sensors**

There are multiple position sensors to ensure accurate placement of the wafer.

A reed switch confirms when the spatula has driven to above the electrode another tells when the spatula has returned to the home position ready for rotation.

A laser illuminates the bottom of the spatula, this laser detects pips on the bottom of the spatula, once the pip is detected the position of the wafer is accurately known.

### **1.2.3.3.3 Pumping System**

Pumping is normally facilitated by an ISO 40 port on the base of the loadlock, although an ISO63 port has been included should a turbo pump be required.

The ISO40 port is connected via a vacuum valve to a "wet" or "dry" pump to provide pumping for the loadlock. A soft pump bypass line ensures the minimum particulate movement during the pumping sequence.

The pumping port is also used for venting the loadlock, again a soft vent mechanism minimises particulate movement.

Upon the pump command the system is initially soft pumped for 1 minute it is then pumped to 80mTorr when the valve is closed and will only re-open if the loadlock pressure exceeds 120mTorr.

### **1.2.3.3.4 Vacuum Gauging**

A piranni gauge measures the pressure in the chamber, this signal is sent to the control PC, and is displayed on the operator interface.

A 3.7Torr pressure switch ensures that the loadlock is at vacuum prior to opening the transfer gate, this is a safety interlock to ensure the operator is never inadvertently exposed to the inside of the process chamber.

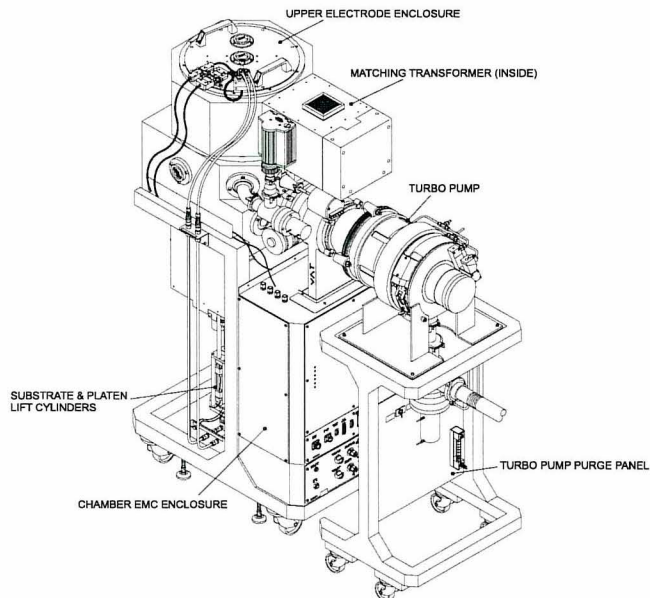
### **1.2.3.3.5 Control System**

A PC housed on the base of the loadlock rack controls the handling system, this interfaces to the loadlock via the electro-pneumatics drawer. This drawer is located just above the control PC and houses all the solenoids to actuate the valves etc.

## 1.2.4 Process chamber

The process chamber assembly is shown in Figure 1.6. Its principal functional components are:

- External components
- ICP electrode assembly
- Frame and EMC enclosure



**Figure 1.15 Process chamber assembly**

### 1.2.4.1 External kit.

The external components consist of all those components fitted to the chamber through its outside walls. These major functional components are:

- Vacuum pumping
- Cold cathode gauge
- Capacitance manometer gauge
- Pressure switch
- Burst pressure kit
- Chamber wall heaters
- Anti-condensation measures

#### 1.2.4.1.1 Vacuum pumping

Vacuum pumping of the process chamber is achieved by a turbo pump backed by a High Vacuum rotary pump. The turbo pump is mounted at the rear of the process chamber and is connected to the chamber through an automatic pressure control (APC) valve and a gate valve. The rotary pump is free-standing. Services required by these pumps, in addition to their power supplies, include water cooling and nitrogen purge gas (via the STS purge pump interface panel). The rotary pump interface unit is described in chamber 1.2.4.4.



### **1.2.4.1.2 Cold Cathode gauge**

The cold cathode gauge is used to measure the process chamber base pressure. It operates in the range  $1 \times 10^{-8}$  to  $1 \times 10^{-2}$  Torr.

### **1.2.4.1.3 Capacitance manometer gauge**

The capacitance manometer gauge is used to measure the chamber process pressure. The process pressure is in the range 0.1 to 20 mTorr.

### **1.2.4.1.4 Pressure switch**

The pressure switch is used as a safety interlock in the 24 V d.c. supply to the gas box solenoid. If the pressure exceeds 3 Torr, the pressure switch operates cutting off the gas supply to the process chamber. It operates in a fail-safe mode.

### **1.2.4.1.5 Burst pressure kit**

The burst pressure kit is used to protect the chamber against overpressure during venting. It is rated at 1.8 bar above atmospheric pressure.

### **1.2.4.1.6 Chamber wall heaters**

Two flat electric heater mats fixed to opposite sides of the process chamber box heat the chamber wall to 50°C.

### **1.2.4.1.7 Anti-condensation measures**

Nitrogen is supplied to the lower electrode RF enclosure to prevent condensation damage. The duration of nitrogen flow is controlled by a timer and solenoid operated pneumatic valve.

### **1.2.4.2 ICP electrode assembly**

The ICP electrode assembly consists of the top electrode assembly bottom electrode assembly and the electrode lift assembly.

#### **1.2.4.2.1 Top electrode assembly**

The top electrode assembly consists of an octagonal upper enclosure into which are fitted various components. On the outside of the enclosure is an extractor fan which is used to cool the RF coil and matching unit.

Inside the enclosure there is a circular ceramic chamber around the outside of which is clamped the RF coil. The plasma is generated in the vacuum inside the ceramic chamber. The gas inlet assembly passes through the chamber top plate via the gas distributor plate into the chamber.

A rectangular box fitted to the rear face of the enclosure contains the RF coil automatic matching unit.

#### **1.2.4.2.2 Bottom electrode assembly**

The bottom electrode assembly consists of the aluminium chamber into which are fitted various components. The aluminium chamber is bolted to the upper enclosure. In one face (near the top of the process chamber) is a slit for the transport carriage to access the platen; in the opposite face (near the bottom) is a port connecting to the APC valve, the HiVac valve and the vacuum pumping system.



The platen consists of the electrode block. RF power and helium back cooling supplies are connected to the electrode block; in case of an electrostatic clamping a high voltage d.c. supply is connected through the electrode to the electrostatic chuck.

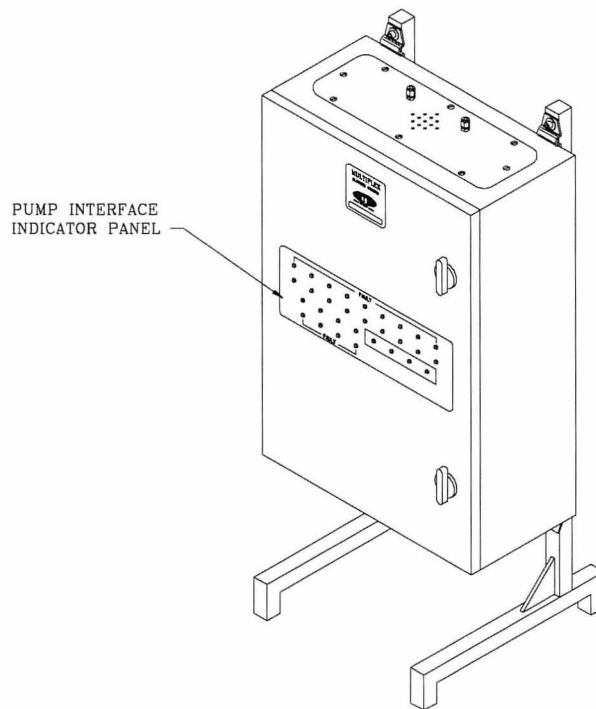
The platen is supported on a flexible stainless steel bellows and is connected to the electrode lift assembly that is used to raise it to the process level. The flexible bellows that is differentially pumped, sits on an adapter which is secured to the chamber base plate.

### 1.2.4.2.3 Electrode lift assembly

The electrode lift assembly essentially consists of two air cylinders with associated coupling acting together for platen lift and a third air cylinder with associated coupling acting alone as the wafer lift. The electrode lift assembly is partly contained in the bottom RF enclosure with its air cylinders beneath this in the frame.

### 1.2.4.3 Frame and EMC (mesc)

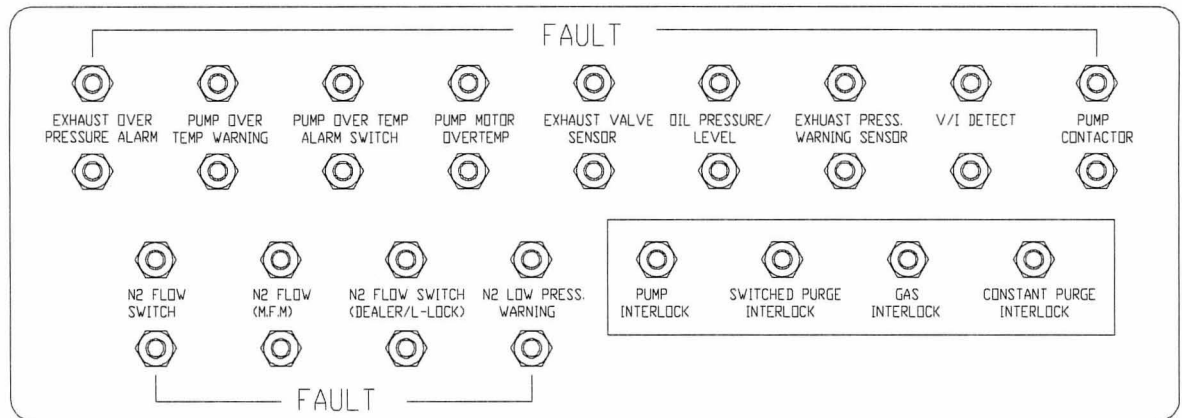
The frame is used to support the chamber and enclose the venting and electrode lift air cylinders. The back and sides of the frame are surrounded by the EMC (mesc) enclosure that is connected to earth (ground) to reduce spurious emissions.



**Figure 1.16 Location of process chamber rotary pump interface unit**

### 1.2.4.4 Process chamber rotary pump interface unit

The pump interface unit controls the application of purge gas to the pump, monitors various sensors, indicates alarm, warning, fault and healthy conditions and activates interlocks. The centre panel of the unit, shown in Figure 1.16 and Figure 1.17, is visible with the door closed. Behind the door a further two panels house reset buttons. For each sensor, there is a FAULT (red) and healthy (green) led. Under normal conditions, the green led is lit. If a fault condition is detected, the green led extinguishes, the red led comes on and the interlocks are activated.



**Figure 1.17 Process chamber rotary pump interface unit**

#### 1.2.4.4.1 Pump pressure, temperature and electrical sensors

The top two rows of five pairs of red and green indicators show the FAULT and healthy status respectively of the pump pressure, temperature and electrical sensors.

**Table 1.10 Chamber rotary pump sensors**

| Component                   | Description                                                                        | Function                   |
|-----------------------------|------------------------------------------------------------------------------------|----------------------------|
| EXHAUST OVER PRESSURE ALARM | Pressure sensor in pump exhaust                                                    | Activates unit interlocks. |
| PUMP OVER TEMP WARNING      | Thermal switch on pump unit                                                        | Activates unit interlocks. |
| PUMP OVER TEMP ALARM SWITCH | Thermal switch on pump unit                                                        | Activates unit interlocks. |
| PUMP MOTOR OVERTEMP         | Thermistor on pump motor                                                           | Activates unit interlocks. |
| V/I DETECT                  | Electronic monitoring of changes in voltage and current of the pump 3-phase supply | Activates unit interlocks. |
| PUMP CONTACTOR              | Contactor on/off sensor                                                            | Activates unit interlocks. |

#### 1.2.4.4.2 Purge gas supply sensors

The two lower left-hand rows of four green and red indicators show the healthy and FAULT status respectively of flow and pressure sensors associated with nitrogen purge gas.

**Table 1.11 Chamber rotary pump sensors**

| Component                  | Description                                | Function                   |
|----------------------------|--------------------------------------------|----------------------------|
| N <sub>2</sub> FLOW SWITCH | Flow switch in nitrogen purge line to pump | Activates unit interlocks. |

#### 1.2.4.4.3 Interlock indicators

The three green indicators in the box on the right-hand side show that a fault has been sensed and the interlocks activated.

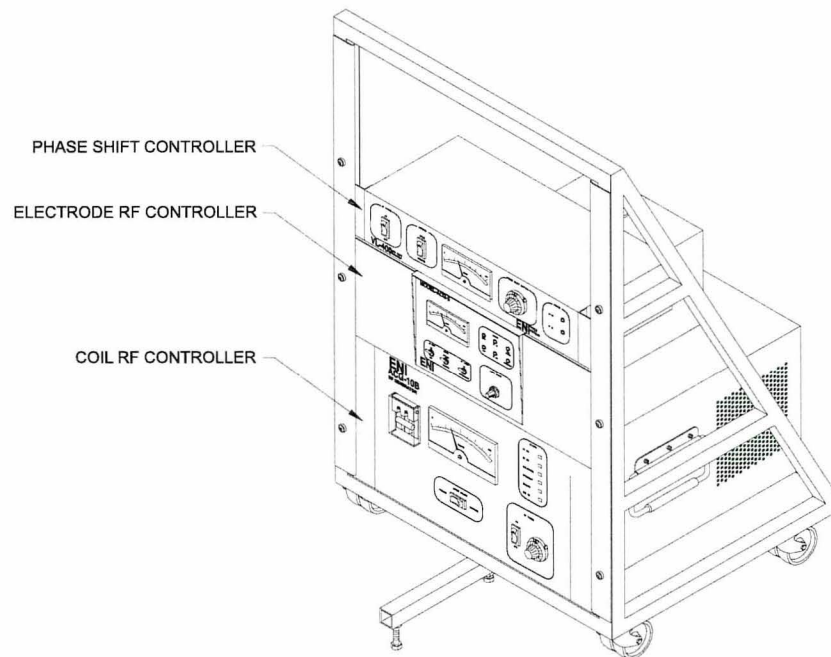
**Table 1.12 Chamber rotary pump sensors**

| Component                | Description                                             | Function                                              |
|--------------------------|---------------------------------------------------------|-------------------------------------------------------|
| PUMP INTERLOCK           | Activated by the pump sensors and purge gas flow switch | Trips out the pump.                                   |
| SWITCHED PURGE INTERLOCK | Activated by the pump sensors and purge gas flow switch | Prevents constant purge routine from being activated. |
| GAS INTERLOCK            | Activated by the pump sensors and purge gas flow switch | Shuts off all process gas supplies.                   |
| CONSTANT PURGE INTERLOCK | Activated by the pump sensors and purge gas flow switch | Prevents constant purge routine from being activated. |

**Note:** Reset switches associated with the various indicators are located behind the unit door.

## 1.2.5 RF stack

The RF stack shown in Figure 1.18, houses the RF generator and phase shift controller for the coil and platen RF excitation supplies.



**Figure 1.18 RF stack**

### 1.2.5.1 Phase shift controller

The phase shift controller is located below the process chamber computer. It produces the 13.56 MHz outputs for the platen and coil RF generators and phase shifts them so that the d.c. self bias of the platen is maximised.

### 1.2.5.2 Electrode RF generator

The electrode RF generator is located below the phase shift controller. It is the source of the RF bias for the platen. Its output is adjustable between 30 and 300 W. Its controls and indicators are described in the manufacturers literature.

### 1.2.5.3 Coil RF generator

The coil RF generator is located below the platen RF generator. It is the source of the RF excitation for the coil. Its output is 1kW. Its controls and indicators are described in the manufacturers literature.

### 1.2.5.4 Turbo pump controller

The turbo pump controller (for use with the process chamber turbo pump) is located below the ion gauge controller. Its controls and indicators are described in the manufacturer's literature.

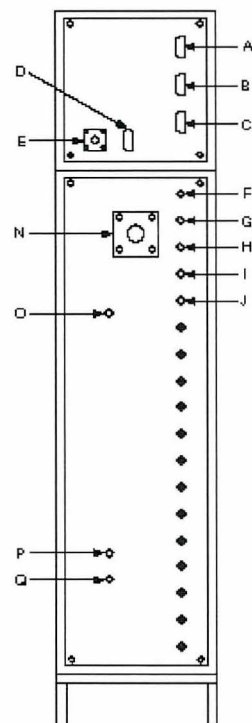


### 1.2.6

#### Remote gas box

**Note:** The gas types used in the following gas box configuration, are included as examples only.

The remote gas box is shown in Figure 1.19. It contains the electronics, solenoid valves and pneumatic valves necessary for the control of the process gases. For safety the cabinet is extracted. All connections are made through one end of the cabinet. At the top is the electrical connection panel. Below this is the gas connection panel. This installation has one gas output (F) and four process gas inputs i.e. Argon (G), Oxygen (H), Octofluorocyclobutane (I) and Sulphur Hexafluoride (J). The panel also houses the purge gas input, compressed air input and extraction port.



Legends:

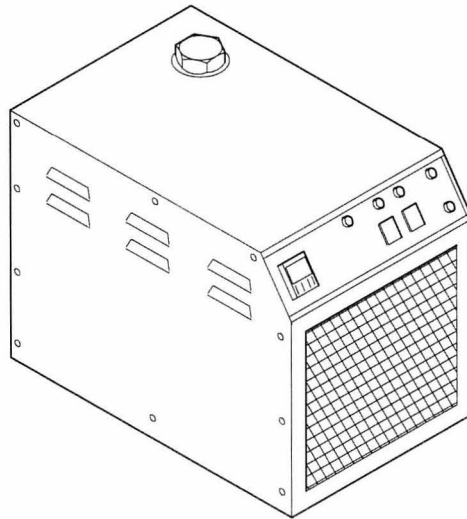
- A R.F.1 Drive
- B Gas Box Control
- C R.F.2 Drive
- D End Point Detector
- E Gas Box Power 24V D.C.
- F Vent
- G Gas 1 In Ar Gas
- H Gas 2 In O<sub>2</sub> Gas
- I Gas 3 In C<sub>4</sub>F<sub>8</sub> Gas
- J Gas 4 In SF<sub>6</sub> Gas
- N Cabinet exhaust connection
- O Mixed Gases Out
- P Compressed Air In
- Q Exhaust
- R Gas 5 SF<sub>6</sub>
- S Gas 6 C<sub>2</sub>F<sub>6</sub>
- T Gas 7 CL<sub>2</sub>
- U Gas 8 SiCl<sub>4</sub>

Figure 1.19 Remote gas box



### 1.2.7 De-ionised water chiller

The DI water chiller is shown in Figure 1.20. It supplies DI water for temperature control of the platen in the ICP chamber. Its controls and indicators are described in the manufacturers literature.



**Figure 1.20** DI water chiller

## 2.1 Wafer handling system

### 2.1.1 General

All wafer handling operations (e.g. inter-chamber gate valve openings and closings, and the process chamber wafer lift mechanism) are controlled and interlocked by the system control computer. The wafer handling sub-processor controls the associated pumping and venting procedures of the loadlock and differentially pumped seals, with the system interlocks preventing operation until the specified parameters for these procedures have been achieved.

A block schematic diagram of the vacuum pumping and instrumentation arrangements of the system is shown in Figure 2.1.

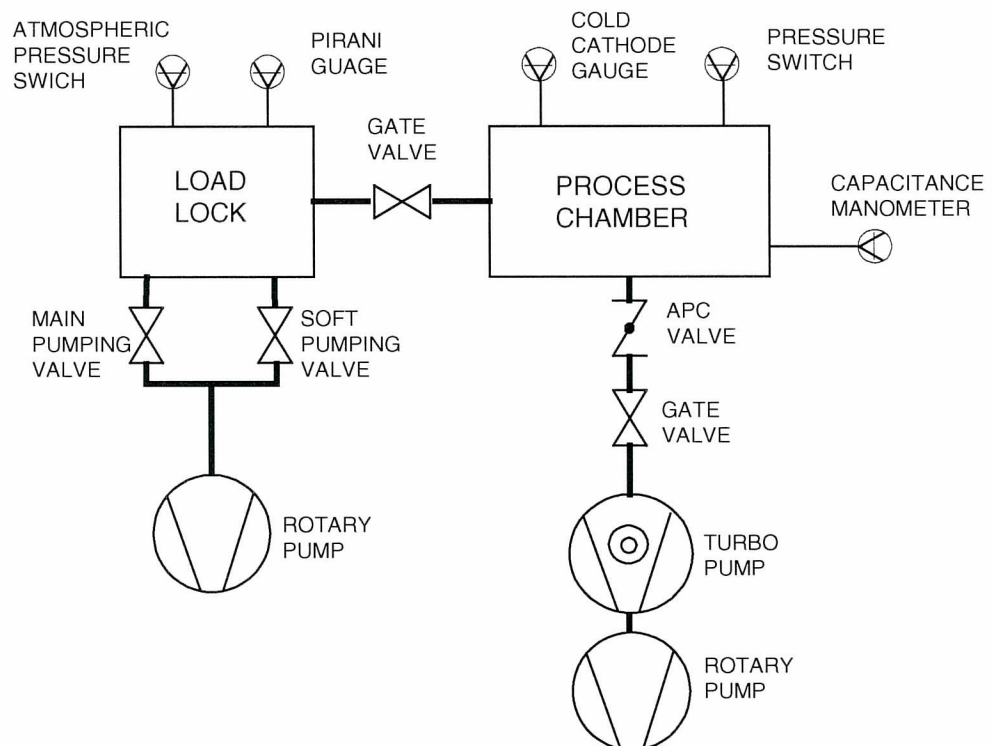


Figure 2.1 System block diagram

### 2.1.2 Loadlock chamber operation

The loadlock chamber is the point of access to the multiplex system. The wafer to be processed is placed on the transfer carriage in the loadlock. After processing the wafer is retrieved from the loadlock.

The wafer lift assemblies (loadlock and process chamber) and vacuum pumping are controlled from the system control computer.

#### 2.1.2.1 Wafer loading and unloading

The loadlock door can only be opened when the loadlock chamber is fully vented to atmosphere. When the loadlock door is opened, a wafer may be placed on or removed from the transfer carriage. The door is closed manually.

### **2.1.2.2 Pumping down**

After the load command has been entered at the system control computer, the loadlock dry vacuum pump starts. The loadlock soft pumping valve opens for approximately 20 seconds followed by the loadlock main pumping valve. The loadlock chamber is pumped down to the user defined base pressure.

### **2.1.2.3 Wafer loading**

After certain data has been entered and selections made at the system control computer, the gate valve between the loadlock and process chambers automatically opens and the wafer is transported out of the loadlock chamber into the process chamber. The gate valve between the loadlock and process chambers now closes.

### **2.1.2.4 Wafer unloading**

The gate valve between the process and loadlock chambers opens and the transport carriage returns the wafer into the loadlock chamber. The gate valve between the process and loadlock chambers now closes and the automatic venting sequence begins.

### 2.1.2.5 Venting sequence

After the appropriate command has been received from the system control computer, the venting sequence starts. The unload sequence is explained with reference to Figure 2.2.

At the start of the venting sequence it is assumed that all valves are closed. The sequence is as follows:

#### Purge

- 1 Valve B opens for 1 second soft venting of loadlock with nitrogen.
- 2 Valve B closes, valve C opens until loadlock is pumped down to base pressure.

**Note:** The purge sequence may be repeated up to 4 times depending on the process selected

#### Vent

- 3 Valve C closes, valve B opens for a pre-set time or until a pre-set pressure is reached for soft venting of loadlock with nitrogen.
- 4 Valve B closes, valve C opens until loadlock is pumped down to base pressure.
- 5 Valve C closes, valve B opens for a pre-set time or until a pre-set pressure is reached for soft venting of loadlock with nitrogen.
- 6 Valve B closes, valve C opens until loadlock is pumped down to base pressure.
- 7 Valve C closes, valve B opens for a pre-set time or until a pre-set pressure is reached for soft venting of loadlock with nitrogen.
- 8 Valve B closes, valve A opens for full venting to atmosphere when the loadlock door can be opened.

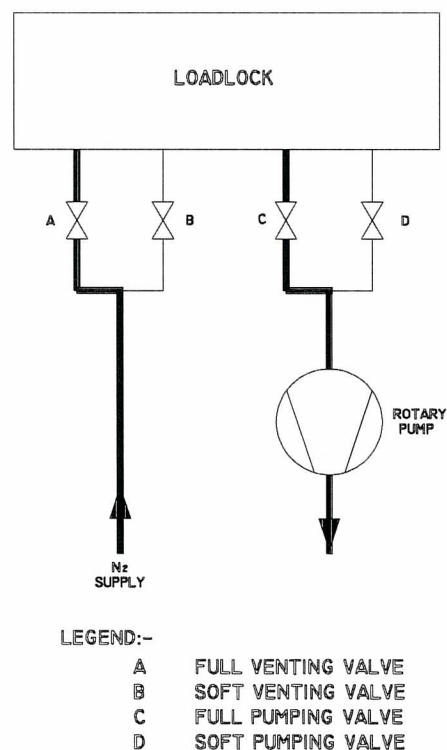


Figure 2.2 Loadlock venting block diagram



## **2.1.3 Process chamber operation**

### **2.1.3.1 Wafer transfer to platen**

With the transfer carriage and wafer positioned over the platen as previously described, a three pin wafer lift mechanism rises from recesses in the platen surface to lift the wafer off the transfer carriage. The transfer carriage, now minus the wafer, retracts into the loadlock chamber and the gate valve between the process and loadlock chambers closes. The wafer lift mechanism lowers back into its recesses, thereby lowering the wafer onto the top surface of the platen.

### **2.1.3.2 Wafer transfer from platen**

On completion of the processing period, the wafer handling system again comes into operation, this time to return the processed wafer back to the loadlock chamber.

First the wafer lift mechanism lifts the wafer off the platen. The gate valve between the process chamber and the loadlock opens and the transfer carriage fully extends into the process chamber to rest directly under the processed wafer. The wafer lift now retracts, thereby lowering the wafer onto the transfer carriage.

## 2.2 ICP system

The Multiplex ICP is a high density low pressure plasma etch system for deep Si trench etching using single 100 mm (or 75 mm) wafers. The plasma is inductively coupled at 13.56 MHz, with independent energy control provided by 13.56 MHz RF biasing of the wafer platen.

### 2.2.1 ICP control system

The ICP control system consists of the process chamber PC, the ICP electronics rack modules and dedicated controllers. These react to stored program information and inputs from sensors to effect control of the process and the system components. A block diagram of the control system is shown in Figure 2.3.

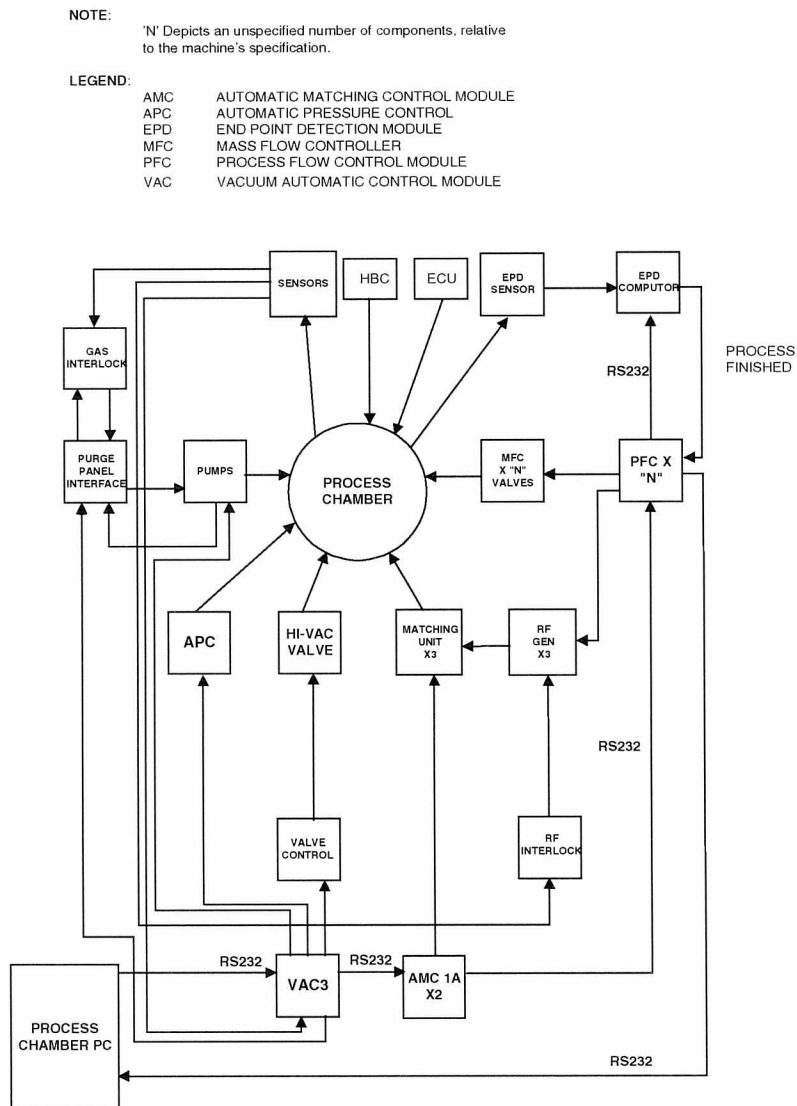
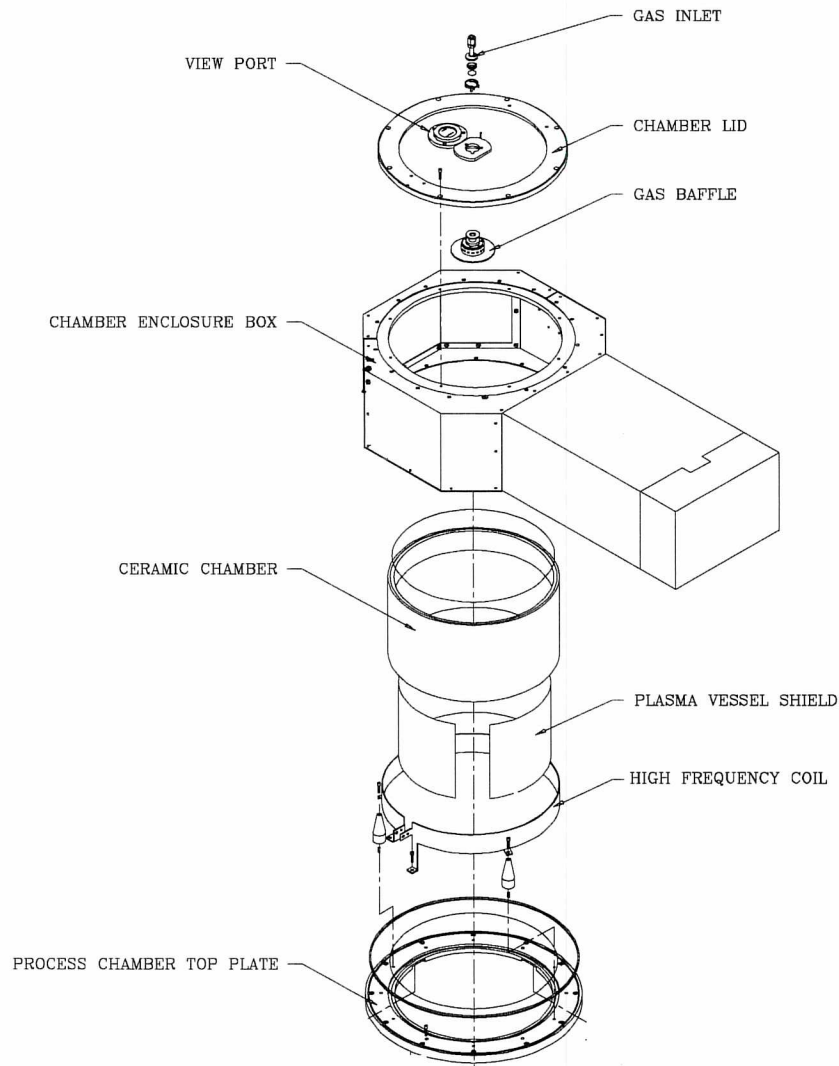


Figure 2.3 ICP control system block diagram

### 2.2.2

#### Process chamber

A simplified cut-away view of the process chamber is shown in Figure 2.4. The plasma source consists of a ceramic chamber with an inductive coil and an aluminium lid with gas inlet. The ceramic chamber, inductive coil and coil matching units are force air cooled. The plasma source is flanged to a low pressure plasma processing chamber. For simplicity the combined plasma source and processing chamber will be termed the process chamber,



**Figure 2.4 Simplified exploded view of process chamber**

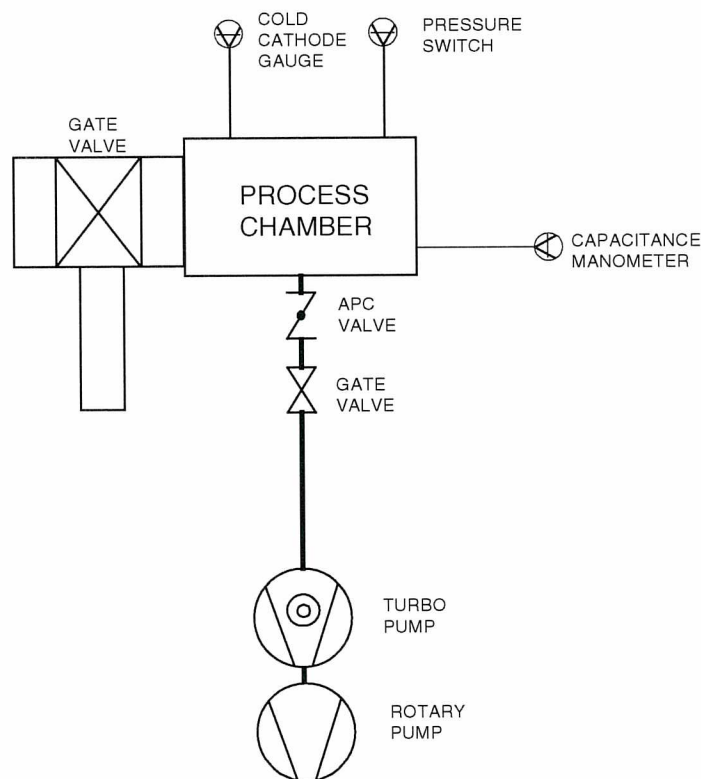
### 2.2.3 Wafer processing

The platen is raised to the process height. When the flow of process gases starts, the wafer is clamped to the platen by electrostatic attraction, and helium cooling of the backside of the wafer commences.

After a user settable period for gas stabilisation, the RF comes on to start the etching process. Etching continues until either the pre-set RF excitation time is reached or the end point detection (EPD) system confirms correct depth of etching. The flow of process gases stops, the He back cooling is switched off and the electrostatic clamping is removed. The platen is lowered and the process chamber is pumped down to base pressure.

#### 2.2.3.1 Process chamber pumping

The process chamber vacuum pumping line consists of the throttle control (or APC) valve, gate valve, turbo pump and rotary dry pump as shown in Figure 2.5.



**Figure 2.5 Process chamber vacuum pumping**

When pumping down from atmosphere, the APC valve is fully open and the gate valve is open. Initially the rotary dry pump pumps the system down, the turbo pump then comes up to speed to take the chamber down to base pressure ( $< 0.1$  mTorr).

#### 2.2.3.2 Gate valve

During processing, the chamber is continuously pumped so the gate valve remains open. The gate valve is closed when the chamber is being vented to atmosphere or if there is a gas line fault condition.

## 2.2.3.3 Throttle control valve

The throttle control valve can operate in either manual or automatic mode depending on the selection made in the SETUP program.

In manual mode, a percentage open from 0 to 100% corresponding to an angle of opening between 0.1 and 90 degrees can be selected. The valve opening is driven to the selected position.

In automatic mode, the angle is pressure dependent. The valve operates to maintain the pressure set in the SETUP program under the control MKS pressure controller (in the ICP electronics rack) and the chamber pressure sensors.

## 2.2.4 Process chamber venting

The process chamber is normally maintained at vacuum and is only vented to atmosphere for essential maintenance. Nitrogen is introduced through the process gas system by a manual control valve in the remote gas box (Refer to chapter 2.4.3).

## 2.2.5 Process gas system

The remote gas box receives the four process gases, nitrogen supply for purging the gas lines and venting the process chamber and compressed air for pneumatic valve operation. The gas, gas mixture or purge/vent supply is selected by the PFCs (process flow controllers) with the flow rates for each gas controlled by its dedicated MFC (mass flow controller). The PFCs also initiate the RF excitation of the coil and bias of the platen.

## 2.2.6 Process RF system

The plasma is inductively coupled at 13.56 MHz via a matching unit and coil assembly outside the process chamber. This provides a high density plasma capable of operating in a very wide process range. Independent energy control is provided by 13.56 MHz RF biasing of the wafer platen, via an automatic power control and impedance matching. A block diagram of the RF system is shown in Figure 2.6.

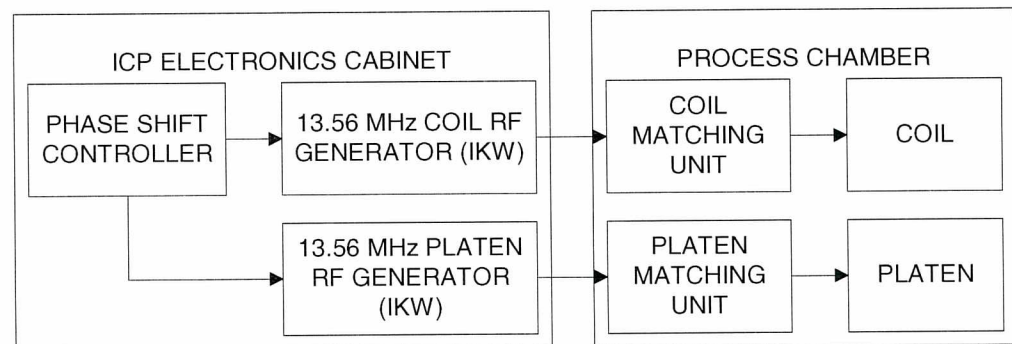


Figure 2.6 RF system block diagram

## 2.2.7 Helium backside cooling

Helium gas is used for aiding backside cooling of the wafer. Helium pressure is sensed by a capacitance manometer and flow controlled by a MFC by the HBC module in the ICP electronics rack to achieve a static pressure of 10 Torr.



### 2.2.8 End point detection system

**Note:** Surface Technology Systems (STS) equipment can accommodate various types of end point detection systems. The following information refers to a Sofie Digitwin system. Consult manufacturer's information for other types of end point detection systems fitted to STS equipment.

End point detection of the etch process is provided by a Sofie Digitwin system. This is a combined system for optical emission spectroscopy and reflectance interferometry. The optical emission sensor is used for end point detection in etch processes.

It monitors the transition of chemically different layers during etching by following a fixed emission line and observing its change due to transition of an interface. Further information on the Sofie Digitwin system is given in the manufacturer's literature.

## 2.3 De-ionised water cooling

Temperature controlled de-ionised water from the DI water heater/chiller is used by the lower electrode (platen) in the process chamber. The DI water stabilises the platen temperature between 5 and 60°C (adjustable on the heater/chiller unit).

The conductivity meter, located in the ICP electronics rack, monitors the de-ionised water supply. If the conductivity reaches a pre-set value, the RF is interlocked.

Connection pipes are provided to enable the chiller to be positioned up to 3 metres away from the rear of the system. Connection is via 3/8" fittings to the rear system service panel.

The water supplied to the system must meet the following specification:

|                           |                                     |
|---------------------------|-------------------------------------|
| <b>Inlet Temperature:</b> | 10 - 25°C                           |
| <b>Inlet Pressure:</b>    | 100 PSI Maximum                     |
| <b>Flow rate:</b>         | 20 Litres/Hour                      |
| <b>Filtration:</b>        | Water to be filtered to 100 microns |
| <b>pH Value:</b>          | 6.0 - 7.5                           |

## **2.4 Nitrogen system**

Nitrogen gas is used throughout the system for purging, venting and anti-condensation measures.

### **2.4.1 Loadlock chamber**

Nitrogen is used at the loadlock chamber for:

- Loadlock chamber purge and vent
- Loadlock chamber rotary pump purge

### **2.4.2 Process chamber**

Nitrogen is used at the process chamber for:

- Process chamber anti-condensation measures
- Process chamber turbo pump purge
- Process chamber rotary pump purge

### **2.4.3 Remote gas box**

Nitrogen is used at the remote gas box for:

- Process gas line purge
- Process chamber vent

**2.5****Hardware interlocks**

Table 2.1 lists the hardware interlocks, the devices that cause them to operate and the effect of them being operated. All hardware interlocks are monitored by software that shuts down relevant control systems and aborts any processing when a hardware interlock is tripped.

**Table 2.1 Hardware interlocks**

| <b>Name of interlock</b>         | <b>Interlocking device</b>                                                                                                                                                                                                                                                                                                        | <b>Effect of interlock</b>                                               |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Electrical (EMO) interlock chain | Emergency stop button<br>Panel micro switches<br>Main system isolator                                                                                                                                                                                                                                                             | Trips out all voltage supplies, including RF and accessories, over 24 V. |
| RF interlock chain               | Electrical (EMO) interlock chain<br>Process chamber top enclosure micro switches<br>Top (coil) matching unit lid micro switch<br>Bottom (platen) matching unit lid micro switch<br>Process chamber gate valve reed switch<br>He backside cooling pressure and flow sensors<br>DI water flow temperature and conductivity sensors. | Trips out both RF supplies, all process gases, purge gas and pumps.      |
| Process gas interlock chain      | Process chamber over pressure switch<br>Process chamber gate valve reed switch<br>Compressed air monitoring unit (air pressure switch)<br>HiVac valve reed switch<br>loadlock rotary pump purge interface panel<br>Process chamber rotary pump purge interface panel                                                              | Shuts off all process gas supplies.                                      |

Table 2.1 Hardware interlocks (continued)

| Name of interlock                           | Interlocking device                                                                                                                                                                                                                                                                                             | Effect of interlock                                                                               |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Loadlock rotary pump<br>purge interface box | Electrical (EMO) interlock chain<br><br>Exhaust over pressure alarm<br>(pressure sensor)<br><br>Pump over temperature warning<br>(thermal switch)<br><br>Pump over temperature alarm<br>switch<br><br>Pump motor over temperature<br>(thermistor)<br><br>Pump motor contactor<br><br>N <sub>2</sub> flow switch | Trips pump, process<br>gas interlock and<br>constant purge gas<br>interlock valve.                |
| Chamber rotary pump<br>purge interface box  | Electrical (EMO) interlock chain<br><br>Exhaust over pressure alarm<br>(pressure sensor)<br><br>Pump over temperature warning<br>(thermal switch)<br><br>Pump over temperature alarm<br>switch<br><br>Pump motor over temperature<br>(thermistor)<br><br>Pump motor V/I detector<br>N <sub>2</sub> flow switch  | Trips pump, process<br>gas interlock,<br>switched purge and<br>constant purge<br>interlock valve. |
| Miscellaneous                               | Process chamber turbo pump<br>switched off<br><br>Process chamber rotary (backing)<br>pump switched off                                                                                                                                                                                                         | Shuts off turbo pump<br>purge gas supply.<br><br>Shuts off backing<br>pump purge gas<br>supply.   |



## 3.1 Computer system

The computer system consists of a single system control computer that provides the operator interface with the system.

The system control computer runs the process program, controls all wafer handling operations (such as chamber wafer lift), loadlock pump down and venting.

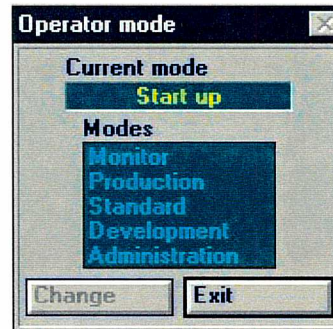
When the system is booted up, the Operator Station Start-up mode is displayed on screen. This system can be operated in six different access levels, (refer to sub-chapter 3.2.) The software program is detailed in Chapter 5.

### 3.1.1 Windows specifics

The functions accessed from the computer are Windows applications. Therefore, manual operation of dialog boxes can be achieved via a mouse, lightpen or the keyboard. When using the keyboard, movement between dialog box functions is by tabbing. The dialog boxes can be selectively disabled when their functions become irrelevant. Then disabled, the functions are greyed.

### 3.2 System operator modes

When the system is booted-up, the software will be in the Start up mode. Apart from providing access to the system operation modes, the Start up mode will permit the operator to open the Help file and Exit the system software.



**Figure 3.1 Operator Mode Dialog**

The software system can be used in any of five operating modes:

- 1 Monitor
- 2 Production
- 3 Standard
- 4 Development
- 5 Administration

Each operating mode is accessed via a password. All mode and password are logged by the data exchange. The password is not case sensitive and can only be changed when the system is operating in the Administration mode. The system default passwords are the first three letters of the Operation mode name (e.g. the password for Monitor mode is mon,). Movement between operating modes is accomplished by password, or via a Confirmation dialog. Table 1.1 identifies the appropriate method.

**Table 3.1 Operating Mode Interchange**

| Change Mode To:- | Method from Monitor Mode | Method from Production Mode | Method from Standard Mode | Method from Development Mode | Method from Administration Mode |
|------------------|--------------------------|-----------------------------|---------------------------|------------------------------|---------------------------------|
| Monitor          | Not Applicable           | Password                    | Confirmation dialog       | Confirmation dialog          | Confirmation dialog             |
| Production       | Password                 | Not Applicable              | Confirmation dialog       | Confirmation dialog          | Confirmation dialog             |
| Standard         | Password                 | Password                    | Not Applicable            | Confirmation dialog          | Confirmation dialog             |
| Development      | Password                 | Password                    | Password                  | Not Applicable               | Confirmation dialog             |
| Administration   | Password                 | Password                    | Password                  | Password                     | Not Applicable                  |

**Table 3.2 Operation Modes, Actions and Functions**

**Table Key**

NO This Action/Function CANNOT be performed in this mode

YES This Action/Function CAN be performed in this mode

| Action/Function                  | Monitor Mode | Production Mode | Standard Mode | Development Mode | Administration Mode |
|----------------------------------|--------------|-----------------|---------------|------------------|---------------------|
| Change passwords                 | NO           | NO              | NO            | NO               | YES                 |
| View Process Recipes             | YES          | NO              | YES           | YES              | YES                 |
| Edit Process Recipes             | NO           | NO              | NO            | YES              | YES                 |
| View Wafer Process Recipes       | YES          | NO              | YES           | YES              | YES                 |
| View Set Values                  | YES          | NO              | YES           | YES              | YES                 |
| Edit Set Values                  | NO           | NO              | NO            | YES              | YES                 |
| Size, minimise and close Windows | YES          | NO              | YES           | YES              | YES                 |
| Edit Options                     | NO           | NO              | NO            | YES              | YES                 |
| Run Processes                    | NO           | NO              | NO            | YES              | YES                 |
| Abort/Hold Process               | NO           | YES             | YES           | YES              | YES                 |
| Transfer Wafers                  | NO           | NO              | NO            | YES              | YES                 |
| Load and Unload Wafer            | NO           | NO              | NO            | YES              | YES                 |
| View Process Sequences           | YES          | NO              | YES           | YES              | YES                 |
| Edit Process Sequences           | NO           | NO              | NO            | YES              | YES                 |
| Open and Load Process Sequences  | NO           | YES             | YES           | YES              | YES                 |
| Run Process Sequences            | NO           | YES             | YES           | YES              | YES                 |
| Abort/Hold Process Sequences     | NO           | YES             | YES           | YES              | YES                 |

### 3.2.1 Monitor mode

The Monitor mode, which provides access to all the main menus, is used for viewing the various stages of a process recipe. Apart from changing the operation mode of the system, NO machine operations can be undertaken in this mode.

Refer to Table 3.2 for a quick reference guide to permitted operator mode actions.

### 3.2.2 Production mode

The Production mode, which is used primarily for selecting, running, holding and aborting valid process sequences, provides protective limited access to the system. As process sequences can only be set-up in either the Development or Administration mode, the operator can elect to change to the Production mode to run the process sequence. This action will protect the process sequence from outside operator interference.

Refer to Table 3.2 for a quick reference guide to permitted operator mode actions.

### 3.2.3 Standard mode

The Standard mode is essentially a combination of both the Monitor and Production modes, with fewer restrictions on the display layout.

Refer to Table 3.2 for a quick reference guide to permitted operator mode actions.

### 3.2.4 Development mode

The Development mode provides almost complete machine control. The functions NOT available in this mode can be accessed from the Administration mode. The Development and Administration modes can be used by both the process and production engineers, covering setting-up and running of process sequences, to system maintenance and testing.

Refer to Table 3.2 for a quick reference guide to permitted operator mode actions.

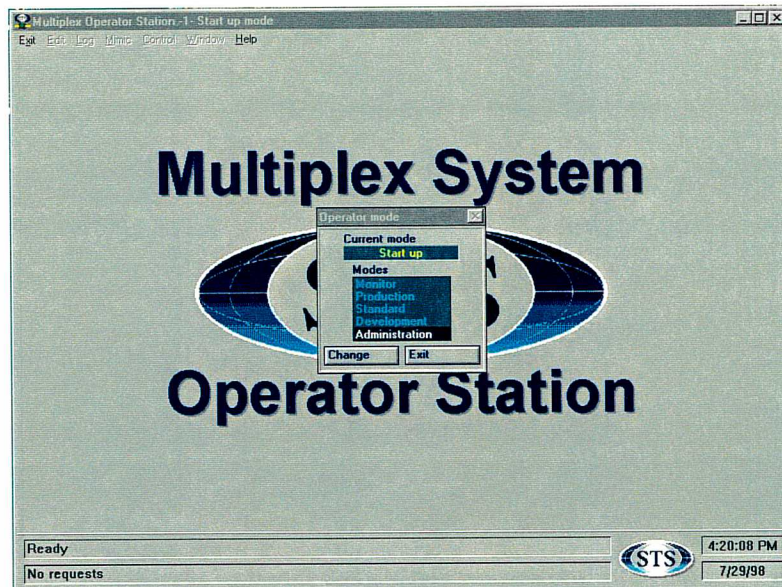
### 3.2.5 Administration mode

The Administration mode provides unrestricted access to the system (subject to hardware and software interlocks). This includes access to the wafer map editing function, and the facility to change the operation level passwords.

Refer to Table 3.2 for a quick reference guide to permitted operator mode actions.



### 3.3 System functional description



**Figure 3.2 Operator Station – 1 – Start up mode**

When the system is booted-up, the Windows front end PC will automatically be booted into the Operator Station Start-up mode. The status bar, at the bottom of the page, will show the message establishing communications. This message indicates the Main Controller program is establishing two way communications with the data exchange, which in turn is establishing two way communications with the process chamber(s) and wafer handling PC's.

Having established communications, the status bar message will change to initialising. During the initialising phase, the Main Controller program is obtaining the machine configuration data from the data exchange. When the status bar indicates Ready, the machine configuration will be accessible from the Operator Station Development and Administration modes.

The other Controller programs (Wafer, Sequence Lock recipe and ♦ \*.\* process chamber recipe editors), log into the data exchange in a similar way to that of the Main Operator Station program. When an Operator Station program is selected from the Development or Administration mode Edit menu, a dialog is displayed indicating Establishing Communications. This is quickly replaced by another dialog indicating Initialising. When the initialising phase is complete, the Operator program dialog is displayed on screen. Each time a Controller program is opened, a number will be displayed after the program heading (e.g. Sequence editor -2-). This number indicates the Sequence editor is the second Controller program currently open. The Main Controller program is usually the first.

When the operator has configured the system for the process required; the process is run from the machine control dialogs. All machine control dialog commands, issued to the Controller programs, wafer handling and process chamber computer, are routed through the data exchange program. The Operator Station programs are prevented from logging out of the data exchange program while a process is running.

♦ denotes a general term for all types of process chambers



CONTROL TECHNOLOGY SYSTEMS

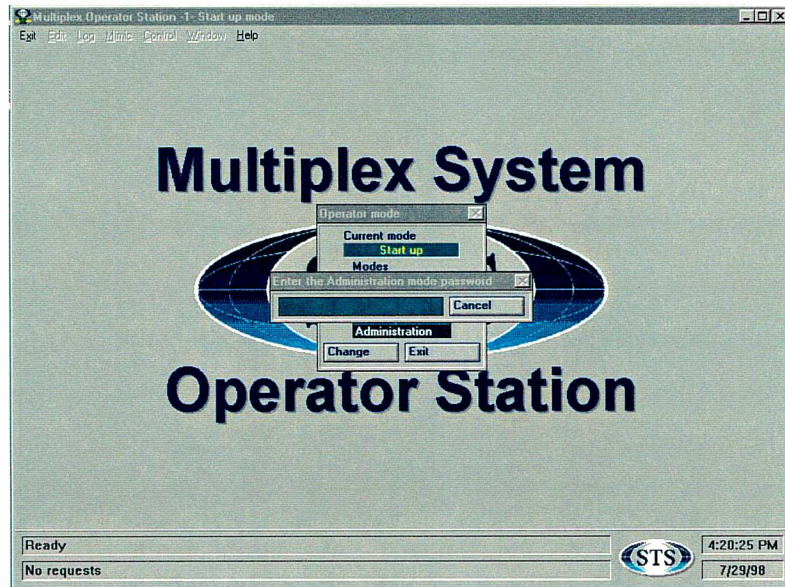


Figure 3.3 System Password Dialog

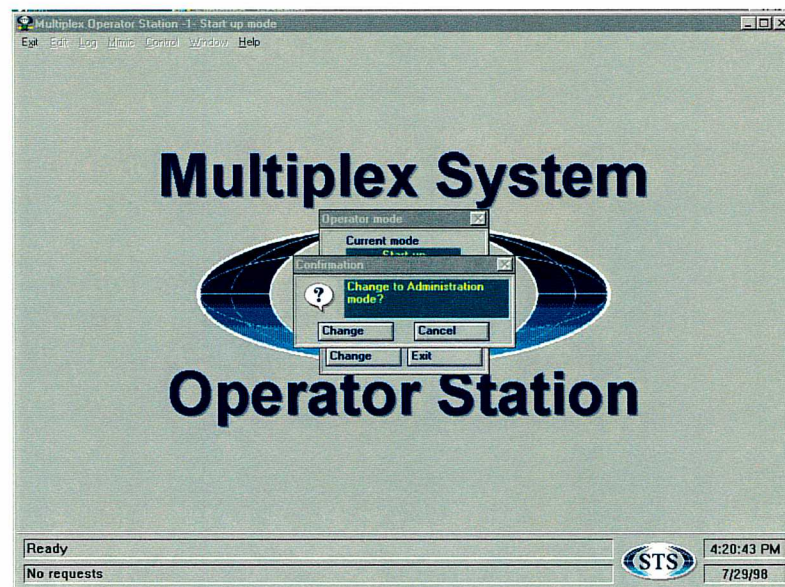


Figure 3.4 Operator Mode Selection Confirmation Dialog

## 3.4 Accessing the system

The following procedure describes how to access the Operator Station program, for the purposes of operating the system. Process and production engineers would normally operate the system in either the Development or Administration mode. Although the method of accessing the system is the same for all modes, this procedure uses the Development mode as its example.

1. Boot-up the system. The Operator Station-1- Start up mode screen, complete with the Operator mode dialog will be displayed (Refer to Figure 3.2).
2. Select a mode from the dialog. The dialog Change button will become active.
3. Click on the Change button. The Enter the ♠ \*\*\*mode password dialog will be displayed (Refer to Figure 3.3).
4. Enter the password (the first three letters of the mode selected) and press Enter. A Confirmation dialog will be displayed (Refer to Figure 3.4).
5. Click on the Confirmation dialog Change button to access the mode selected.

♠ denotes a general term for all Controller program Operator modes

## 3.5 Main Operation Station program menu's

This sub-chapter will describe the options available under each Operator Station program menu, operating in the Administration mode.

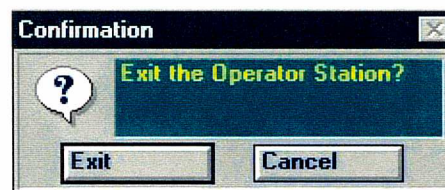
When the Operation Station program has been accessed, all controllers, dialogs and mimics will be configured for the system.

**Note:** The controllers, dialogs and mimics are representative of typical machines and may NOT reflect your machine configuration exactly.

The Operation Station program menu's are:

- Exit
- Edit
- Log
- Mimic
- Control
- Window
- Help

### 3.5.1 Exit menu



**Figure 3.5 Exit Confirmation Dialog**

When the Exit menu is selected, a Confirmation dialog will be displayed on screen. Click on the Exit button to log-out of the Operator Station. This action logs the Operator Station program out of the data exchange. If a process is still running, a warning is given and the exit is prevented.

### 3.5.2 Edit menu

The Edit menu comprises the following options:

- Preferences
- Operator mode
- Change password
- Wafer editor
- Sequence editor
- Process chamber (\*.\*) recipe editor

The Wafer, Sequence and Process chamber recipe editors are described in Chapter 5 of this manual.



## 3.5.2.1 Preferences option

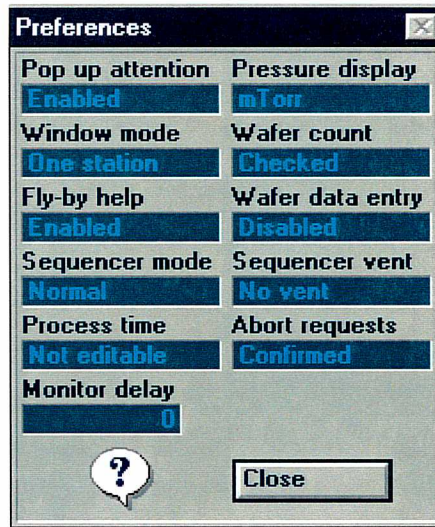


Figure 3.6. Preferences Dialog

The Preferences dialog box can only be edited from Administration and Development modes.

To change a setting use the mouse, point to the field and left-click the mouse to view the selection and then point to and left click on the setting of your choice.

| Feature                 | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Pop up attention</b> | <p>Allows the operator to 'Enable'/'Disable' the 'Alarms and Requests' dialog box.</p> <p><b>Enabled</b> All system alarms and associated operator requests will trigger the display of the 'Alarms and Requests' dialog box. A message will also be shown in the window status area.</p> <p><b>Disabled</b> A system alarm, or an associated operator request, will NOT display the 'Alarms and Requests' dialog box. However, the operator is made aware of any system alarm or request by a message displayed in the window status area.</p> |
| <b>Window mode</b>      | <p>The Window mode options are:</p> <p><b>Normal</b> Allows all windows of all parts of the process to be viewed at a time.</p> <p><b>One window</b> Allows one window of one part of the process to be viewed at a time.</p> <p><b>One station</b> Allows windows of one part of the process to be viewed at a time.</p>                                                                                                                                                                                                                       |
| <b>Fly-by help</b>      | Allows the operator to 'Enable'/'Disable' the fly-by help display.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

| Feature                 | Action                                                                                                                                                                                                                                                                                                    |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Sequencer mode</b>   | <p>Allows the operator to set 'Normal' or 'Cycling' mode processing.</p> <p><b>Normal</b>            Used during normal process procedures.</p> <p><b>Cycling</b>            Used for trials or tests after repair/maintenance procedures – will complete continuous runs with the same wafer/wafers.</p> |
| <b>Process time</b>     | The operator can select if the process time can be edited in 'Production' mode.                                                                                                                                                                                                                           |
| <b>Monitor delay</b>    | Allows the operator to set a delay, in minutes, before the screen returns to default 'Monitor' mode. Return to other modes will require password entry.                                                                                                                                                   |
| <b>Pressure display</b> | <p>Allows the operator to set the pressure readings to display in either:</p> <p><b>Milli-Torr (mTorr).</b></p> <p><b>Torr.</b></p> <p><b>Milli-Bar (mBar).</b></p>                                                                                                                                       |
| <b>Wafer count</b>      | <p>Allows the operator to set 'Checked'/'Not checked'.</p> <p><b>Checked</b>            The process will stop if the wafer mapping is incorrect.</p> <p><b>Not checked</b>      The process will assume that the wafer mapping is correct</p>                                                             |
| <b>Wafer data entry</b> | Allows the operator to 'Enable'/'Disable' the wafer entry spreadsheet for recording details specific to the wafer. If this is enabled, the spreadsheet will be displayed when the process is initiated.                                                                                                   |
| <b>Sequencer event</b>  | <p>Allows the operator to set 'Vent'/'No vent'.</p> <p><b>Vent</b>                The system will vent after a sequence run.</p> <p><b>No Vent</b>            The system requires manual activation of the vent sequence.</p>                                                                             |
| <b>Abort requests</b>   | Allows the operator to ask for 'Abort' requests to require a check box.                                                                                                                                                                                                                                   |

### 3.5.2.2 Operator mode option

Refer to chapter 3.1.



### 3.5.2.3 Change password option



**Figure 3.7 Change Password Dialog**

The system is dispatched with default passwords. The default passwords, indicated in chapter 3.1, can be changed to suit operator requirements (Refer to sub-chapter 3.5.2.4 and sub-chapter 3.5.2.5). When the Change password option is selected, the Change password dialog (Figure 3.7) will be displayed on screen. The current operating mode will be highlighted.

### 3.5.2.4 Changing the operator mode password

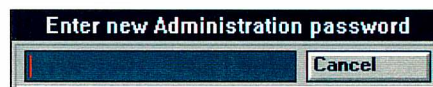
**Note:** The following procedure is applicable for all Operator mode password changes. For the purposes of this example, the Administration mode has been selected.

1. To change the password, select the mode required from the Change password dialog.



**Figure 3.8 Enter Change Password Dialog**

2. Click on the dialog Change button. The Enter change password dialog will be displayed on screen (Refer to Figure 3.8).



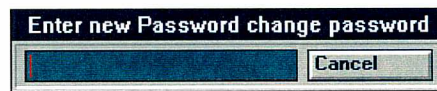
**Figure 3.9 Enter New \*\*\* Mode Password Dialog**

3. Insert the change password (CHA) and press Enter. The Enter new ♠ \*\*\* password dialog will appear on screen (Refer to Figure 3.9).
4. Set the new password (up to 20 characters) and press Enter. The NEW password is now logged in the system.

♠ denotes a general term for all Controller program Operator modes

## 3.5.2.5 Changing the PASSWORD for the password

1. To change the PASSWORD, select the Password option from the dialog.
2. Click on the dialog Change button. The Enter change password dialog will be displayed on screen (Refer to Figure 3.9).



**Figure 3.10 Enter New Password Change Password Dialog**

3. Insert the change password (CHA) and press Enter. The Enter new Password change password dialog will appear on screen (Refer to Figure 3.10).
4. Set the new password (up to 20 characters) and press Enter. The NEW password is now logged in the system.

## 3.5.3 Log menu

The data logging facility permits the user to access and process the data (Process parameters) which are automatically logged in the process chamber computer each time a programmed process is run. The log menu options are:

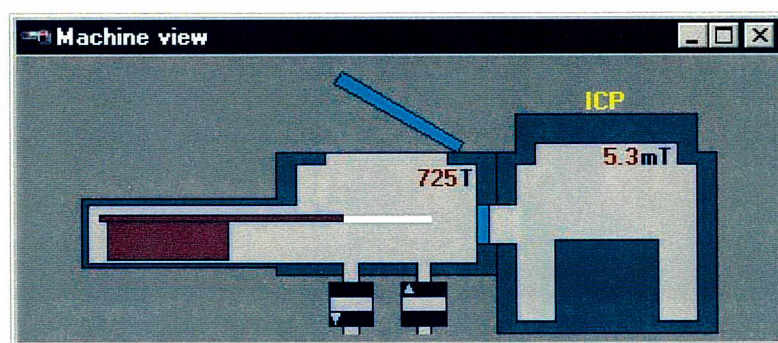
- Machine log
- \*. \* Datalog \*. \*

## 3.5.4 Mimic menu

The Mimic menu provides access to the mimic displays. The mimics reflect the machine configuration and each mimic display provides a graphical representation of the systems operation, and shows the system components measured values. The mimic displays are:

- Machine view
- \*. \* process view

### 3.5.4.1 Machine View

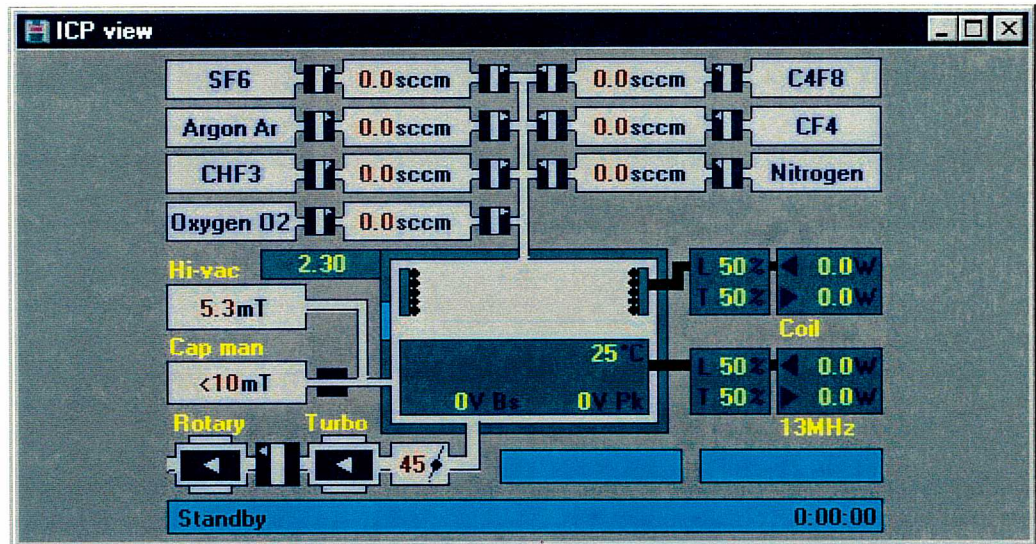


**Figure 3.11 Machine View Mimic**

The machine view mimic shows the position of the wafer transfer arm in relation to the process chamber. When the process is being run, the mimic shows the vacuum pumping of the loadlock through the lock pumping valve, transfer of the wafer through the transfer gate to and from the process chamber and then the venting of the loadlock through the lock venting valve. The mimic display shows the real-time pressures of the loadlock and process chamber.



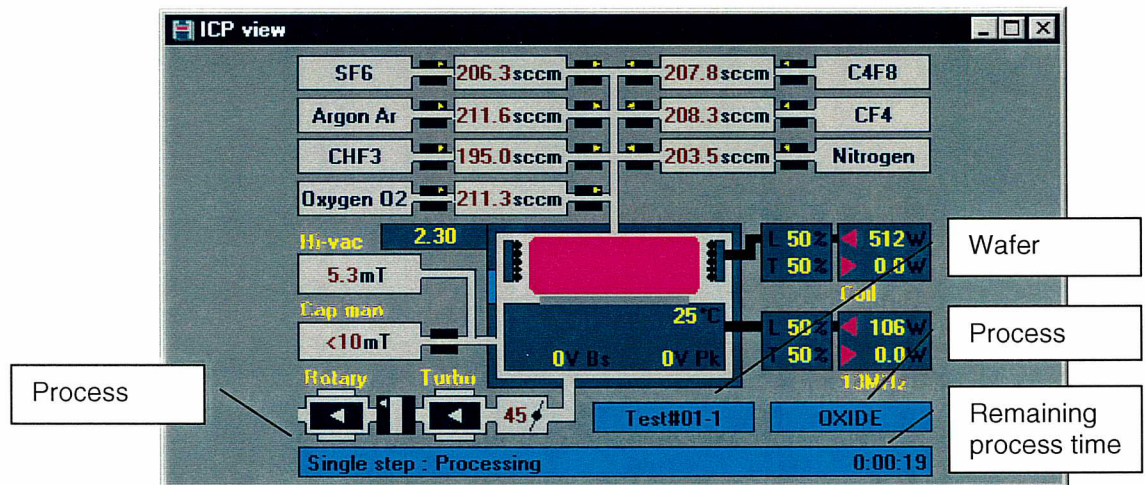
### 3.5.4.2 Process chamber mimic



**Figure 3.12 Process Chamber Mimic (ICP shown)**

The process chamber mimic display shows the:

- Gas system configuration to the process chamber, including the gas type and measured flow rate
- Vacuum pumping system configuration
- Operating temperature of the lower and, where applicable, the electrode
- Values and programmed configuration of the RF generators
- Three status fields, which provide textual information on the current process operating conditions



**Figure 3.13 Process Chamber Mimic (Status Fields)**

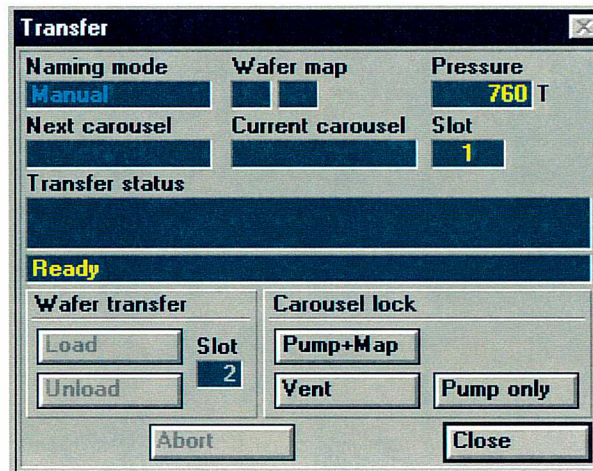
The status field below the chamber identifies the wafer being processed; the field below the RF generators shows the process being run, and the status bar at the bottom of the mimic shows the type of process (e.g. Standby, single step etc). A process count down indicator is displayed at the end of the status bar.

## 3.5.5 Control menu

The Control menu provides access to the automatic and manual machine control dialogs. The dialogs are:

- Sequencer (automatic control)
- Transfer
- \*. \* process chamber(s)

### 3.5.5.1 Transfer control dialogs



**Figure 3.14 Transfer Control Dialog**

The Transfer control dialog permits manual control of the movement of a wafer in the machine. Each Transfer control dialog incorporates an upper and lower status area. The upper status area will indicate the current or last action, performed from the dialog box. The lower status area shows the current state of the latest command, issued from the dialog box. The command status can be any of the following:

| Command Status     | Meaning                                                                                                                                                                                                                                                 |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ready              | Awaiting a command                                                                                                                                                                                                                                      |
| Running            | Executing the command                                                                                                                                                                                                                                   |
| In use             | The destination of the command is being used by another control dialog                                                                                                                                                                                  |
| Waiting for access | Waiting for access to execute the command                                                                                                                                                                                                               |
| Failed             | The dialog has failed to execute the command. If a dialog command encounters an operational fault, it enters the Failed mode. The failure must be acknowledged, prior to continuing, by activating the Accept (renamed from Abort) button on the dialog |

The Transfer control dialogues have an Abort facility that can be used to abort a queued command (in its Waiting mode), or to abort a current operation. When the abort request has been acknowledged, the dialog status returns to Ready.

The function and operation of the Transfer control dialog is described in Chapter 5 of this manual.



## 3.5.6 Window menu

In addition to the standard Windows MDI functions (Tile windows, Cascade windows and Arrange icons), the Windows menu provides the following options:

- Set default options
- Alarms and requests
- Calculator
- Show stopwatch/show clock.

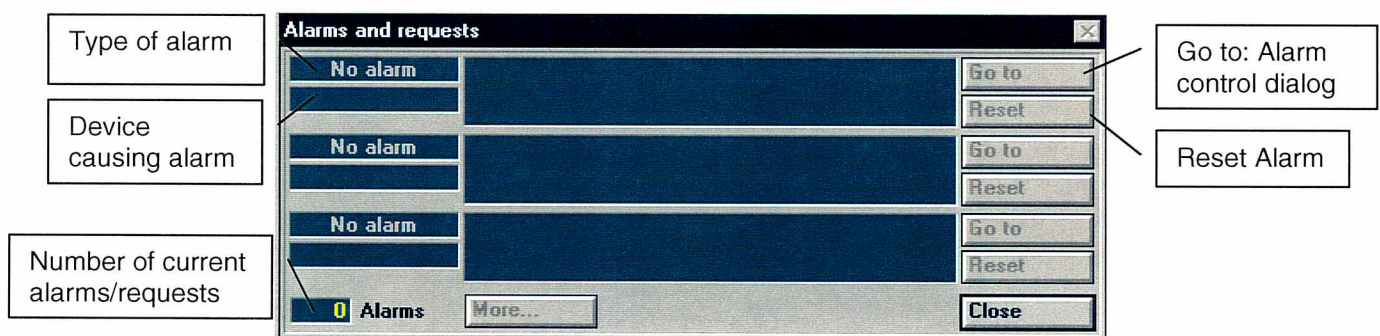
### 3.5.6.1 Set default options

When this option is selected, the Process view, Machine view and Transfer dialogs are displayed on the operator station window.

When the Calculator option is selected, the Windows calculator dialog is displayed on screen.

The Show stopwatch/show clock option toggles between the stopwatch and clock display located on the lower right hand side of the screen. Depending on the current display mode, either the show stopwatch or the show clock option will be displayed.

### 3.5.6.2 Alarm and requests



**Figure 3.15 Alarms and requests Dialog**

When the Alarm list option is selected, the Alarm and requests dialog is displayed on screen. The dialog shows current alarm conditions and outstanding operator requests. The frequency with which the Attention dialog appears on screen, is controlled by the settings selected on the Preferences dialog (Refer to sub-chapter 3.5.2.1).

## 3.5.7 Help menu

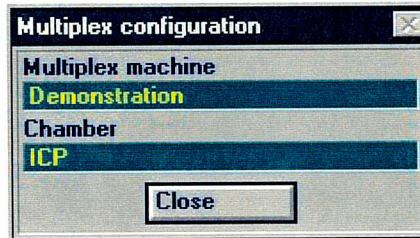
The Help menu comprises the following options:

- Contents
- Search
- Configuration
- Versions
- About

The Contents and Search options are standard help options which allow the operator to view the on-screen help contents list or to search for information using a key word.

## 3.5.7.1 Configuration option

When the Configuration option is selected, the Machine Configuration dialog is displayed on screen.

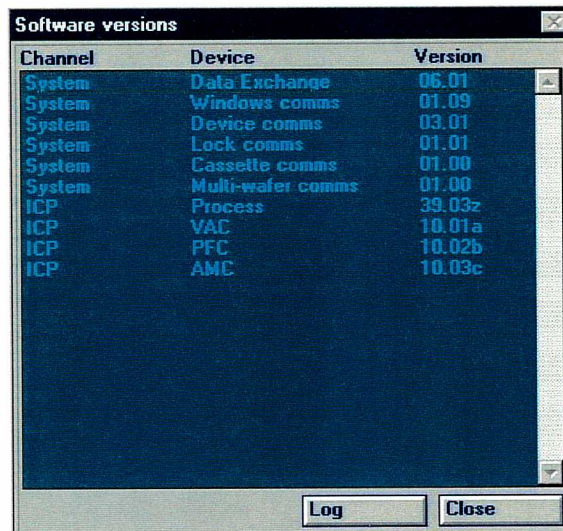


**Figure 3.16 Machine Configuration Dialog**

The Machine Configuration dialog details the machine equipment layout in relation to the dealer unit ports.

## 3.5.7.2 Versions option

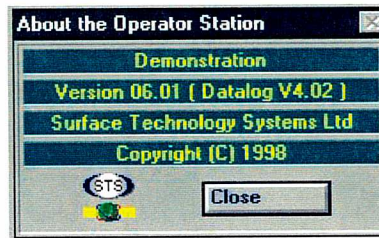
When the Versions option is selected, the Software versions dialog is displayed.



When the Log button is selected, an information dialog is displayed informing the operator that the version information had been recorded in the operator station log.

### 3.5.7.3 About option

When the About option is selected, the About the Operation Station dialog is displayed.



**Figure 3.17 About the Operation Station Dialog**

The About dialog shows the system software release version number.

### 3.6 Software interlocks

Software interlocks prevent or abort a software function (Refer to Table 3.3).

**Table 3.3 Software interlocks**

| Chamber  | Interlocking device                 | Comment                                                                                                                                                                                 |
|----------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Loadlock | Loadlock lid reed switch            | Loadlock lid must be shut before pumping down to base pressure can commence.                                                                                                            |
|          | Loadlock Pirani gauge               | Loadlock must be pumped down to base pressure before loadlock gate valve can be opened.<br><br>Chamber must reach set pressure criteria on loadlock purges before venting can commence. |
|          | Nitrogen flow switch                | Loadlock nitrogen purges must be completed before venting can commence.                                                                                                                 |
| Process  | Chamber high vacuum gauge           | If set pressure is exceeded the process gas interlocks trip.                                                                                                                            |
|          | Chamber capacitance manometer gauge | If set pressure tolerances are exceeded, process gas interlocks trip.                                                                                                                   |
|          | Chamber gate reed switch            | If chamber gate is open, the RF/process gas interlocks trip and process aborts.                                                                                                         |
|          | End point detector                  | Process aborts when end point reached.                                                                                                                                                  |

**Note:** Process aborts if processing tolerances are exceeded (e.g. chamber pressure, wafer susceptor temperature, process gas flow, He backside/RF cooling, matching unit, etc.). Abort process command pauses RF process sequence only.