

## Primaxx MEMS-CET: Process Module Safety Features, Interlocks and Alarms

The range of Primaxx Micro Electromechanical Systems Clean Etch Technology (MEMS-CET) Systems, including the MEMS-CET Process Module, has been designed and tested in accordance with SEMI Standards Safety Guidelines.

Safety features have been evaluated to the SEMI S2-1102 Product Safety Assessment, the SEMI S8-0701 Ergonomic Assessment, and the SEMI S14-1102 Fire Risk Assessment.

### Lockout/Tagout Devices

Lockout/Tagout Devices are provided to ensure that all hazardous energy sources can be turned off and locked in the off position for system maintenance.

#### Primary Power Switch Lockout/Tagout

Primary power for the MEMS-CET Process Module is supplied by either the Electrical Control Cabinet for a cluster tool configuration, or by the Control Tower for a stand-alone process module. Each of these configurations includes a primary power lockout/tagout switch for main electrical power lockout.

#### Pressurized Gas/Liquid Supply Lockout/Tagout Valves

Clean Dry Air (CDA) to open the pneumatically operated valves is supplied through a single Lockout/Tagout Isolation Valve located on the rear of the Gas Control System Enclosure. This valve can be padlocked only in the closed position to lock out the CDA supply pressure during maintenance. This CDA lockout procedure prevents the pneumatically operated isolation valves for the Nitrogen ( $N_2$ ), Hydrogen Fluoride (HF), CDA, and alcohol lines from being opened.

#### Hydrogen Fluoride Supply Lockout/Tagout Valve

A properly ventilated, hazardous gas supply cabinet (customer provided) equipped with appropriate Lockout/Tagout devices is required to supply Anhydrous Hydrogen Fluoride (HF) gas to the MEMS-CET process module(s).

### Gas System Ventilation

Gas control elements and the alcohol supply and alcohol bubbler components are located in a ventilated, stainless steel Gas Control System Enclosure located within the process module.



*Stand-alone 3-wafer MEMS-CET Process Module*

### Key-locked Control Cabinets

The Gas Control System Enclosure includes two “windowed” doors with mesh-reinforced glass that are equipped with key-locked latches to prevent unauthorized entry. In addition, door interlock switches close all gas and liquid isolation valves if either door is opened during operation.

### Leakage Detection

Sensor/transmitters located inside the process module detect the presence of ppm concentrations of either HF or alcohol in the Gas Control System Enclosure. Leakage concentrations in excess of 25% of the OSHA Threshold Limit Value (TLV) for HF, or 25% of the OSHA Lower Explosive Limit (LEL) for alcohol, activate an audible and visual alarm on an independent Gas Leak Detection Controller. The CET process is halted, and all liquid and gas isolation valves close.

## Software Alarms

The control software is configured with alarms and screen prompts to reduce unsafe operation due to operator errors or hardware faults. The software presents three color coded alarm levels to alert the operator:

### Error Alarm - RED

An Error Alarm signals a critical event. This alarm stops the CET process until the alarm condition is corrected.

Recipe alarms occur when a recipe parameter value is outside the allowable tolerance limits for that parameter (defined by the user). If the out-of-tolerance condition exists longer than the preset time limit, the control software will stop the CET process, turn off all gas flows, pump the reactor to base pressure, and wait for instructions.

### Warning Alarm - YELLOW

Warning alarms signal an event that may need operator attention, but this condition does not stop the CET process cycle.

### Informational Alarm - BLUE

This category presents equipment status information only.

## Hardware Alarms

In the event of any hardware interlock fault, the control software graphical user interface screen displays an alarm to notify the operator of the condition:

- Gas System Interlock Fault (Error Alarm)
- Exhaust System Interlock Fault (Error Alarm)
- HF Vapor Detected (Error Alarm)
- Methanol Vapor Detected (Error Alarm)
- Drip Pan Liquid Detected (Error Alarm)
- Reactor Slit Valve Open (Warning Alarm)
- Methanol Level Low (Warning Alarm)

### Chamber Over-Temperature Switch

The chamber assembly is equipped with an over-temperature snap-switch that disables all reactor heaters if the chamber skin temperature rises above 101 -108 °C.

### Hardware Safety Interlocks

Hardware Safety Interlocks directly activate electrical switch contacts to initiate process module safeguards that protect personnel and equipment from potentially hazardous conditions.



### Emergency Machine Off (EMO) Buttons

Located on the MEMS-CET Process Module and the Control Tower, EMO buttons power-down the entire MEMS-CET System and close all pneumatically operated gas and liquid isolation valves when pressed.

### Gas Control Safety Interlocks

Gas Control Interlocks stop all process gases and liquid flows when activated:

- Gas Control System Enclosure Gas Panel Door Switch .
- Gas Control System Enclosure Liquid Panel Door Switch.
- Gas Box Exhaust Switch.
- Atmosphere Switch 1 protects the reactor chamber from over-pressurization.
- Atmosphere Switch 2 stops all gas and liquid flow to the reactor upon loss of vacuum.
- Slit Valve Switch activates when slit valve is open.
- HF Gas Sensor/Transmitter Alarm activates at 25% TLV\* for HF.
- Methanol Vapor Sensor/Transmitter Alarm activates at 25% of LEL\*\* for Methanol.
- Drip Tray Level Sensor Switch.

\* OSHA Threshold Limit Value (TLV)  
\*\* OSHA Lower Explosive Limit (LEL)



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