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Taking Advantage of the SEMI BOLTS-M Interface

It has been a common practice within the semiconductor equipment industry to use the standardized wafer input/output loadport interfaces on 300 mm tools to implement optional processes and customer “specials.”

The wafer I/O stations were standardized by SEMI when the industry transitioned to 300 mm wafers. SEMI’s objective was to avoid the proliferation of multiple input/output methods that occurred with 200 mm and smaller wafers, thereby simplifying 300 mm factory automation and increasing fab efficiencies. The standards succeeded wildly, with nearly all 300 mm process and metrology tools utilizing the Front Interface Mechanical Standard (FIMS). The implementation typically includes an Equipment Front-End Module (EFEM), a wafer handler, wafer aligner and multiple loadports. The loadports must conform to SEMI E63 (also referred to as the BOLTS-M interface). EFEM manufacturers typically include two to four loadports on the front of the EFEM and have recently begun defining additional BOLTS-M interfaces on the sides of the EFEM as well.

Tool suppliers are now using the BOLTS-M interface to add optional modules to their EFEM in order to extend product performance, facilitate product configurability, and accommodate customer “specials” without impacting the rest of the tool. There are several key benefits and design considerations to take into account when implementing a BOLTS-M module.

BOLTS-M benefits

Benefits in utilizing the BOLTS-M module include:

- Process and metrology modules can be interchanged with the loadports, allowing end user flexibility.
- Product configurations can be changed late in the tool manufacturing cycle without impacting lead time.
- Tool performance can be extended with options or customer specific “specials” without adding complexity to the core tool.
- Automation cost for the options is reduced as the existing wafer handler is used for load/unload.
- Tool architecture is simplified by providing a “dividing line” for functionality.
- Field repair costs are reduced due to easy interchangeability and replacement.

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BOLTS-M module design considerations

While taking advantage of the BOLTS interface is attractive, there are some challenges to overcome in order to achieve a successful implementation.

Particle contamination: Controlling particle contamination is critical, especially for front-end-of-line tools. Clean airflow management, front and backside particle management and metals contamination must all be carefully considered. While it is tempting to use the EFEM's clean air as a source for the BOLTS-M module, this can result in a compromised airflow. An alternative is to integrate a small ULPA onto the module to provide laminar airflow. It is relatively easy to model the airflow for a particular EFEM/BOLTS-M implementation with CFD analysis to verify the design. For an example of an integrated ULPA filter to a BOLTS compatible module, click on the link below.

Example of integrated ULPA module

While maintaining clean laminar airflow above the wafer is critical for frontside particles, backside particles require a different approach. As requirements for reduction in backside particles content and size continue to become more stringent, and wafer edge grip may not be applicable, new methods for contacting the wafer must be implemented. In addition, heightened concern over metal contamination drives the introduction of new coatings and materials for the wafer chuck and end effector. In this regard, similar design approaches can be used for the BOLTS-M module as would be applied to the tool chuck. For an example of a low backside contact wafer chuck, click on the link below.

Example of low contamination chuck

Vibration: Vibration transmission from the EFEM to the BOLTS-M module must be considered if the process is vibration sensitive. Typically, this is of particular concern if the BOLTS-M module is housing an imaging or metrology application. Moreover, transmitted vibration from the BOLTS-M module may also impact performance of the tool. There are a number of means to solve these problems, both structurally and with active or passive vibration control. Vibration characterization and testing must be included in the design verification phase.

Footprint: One of the benefits of the BOLTS-M standard is also one of the most restrictive. The standard places tight restrictions on the dimensions of the module. If the module will be mounted to the front of the EFEM, it must meet all of these dimensions or it will not be compliant. If the module mounts to the side of the EFEM, the height restriction of the module can be relaxed and, to some extent, the depth can be relaxed as well. It is necessary to pay careful attention to packaging the electronics and supporting components in the necessary space, while maintaining cooling airflow and serviceability. For a few examples of BOLTS packaging, click on the link below.

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Example of BOLTS-M packaging

Serviceability: Typically the BOLTS Module should be serviceable by one technician, including mounting and dismounting the module. Depending on the weight of the module, this may require an installation cart. The cart can be built into the module if “tip-over” standards are met—meeting the tip-over requirement is challenging, since modules are tall, with a short wheelbase. It is also possible to use a special cart for installation and removal, although this means the cart needs to be stored near the end user. Service access is often restricted to front only, as the module may be mounted between two loadports, with service from the rear restricted by the EFEM. With proper design, it is possible to remove the unit entirely for major service and reinstall without re-teaching the robot.

Modular architecture: While not specifically required, the electrical and software architecture of the BOLTS-M module should also be modular. Outer covers should be designed to match the tool’s overall industrial design. Facilities are typically introduced through a single location from the EFEM. The module is architected with its own controller that works as a slave to the tool controller simplifying software, testability and modularity. Controllers can include PC, PLC and single board computers (SBC).

Summary

The SEMI BOLTS-M offers a standard interface to interchange loadports with custom process/metrology modules. Taking advantage of the BOLTS-M interface offers tool performance enhancements and improved product configurability. Careful design consideration for cleanliness, vibration, footprint and serviceability requirements will lead to a successful implementation.

For additional information on BOLTS-M module implementations, click the links below or contact Ernie Evans, PE at Owens Design at 510-661-2120.

Link to BOLTS-M solution set

Link to Loadport case study

Link to Wafer Heating & Cooling solution set

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