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TECHNICAL INFORMATION AND PRODUCT SOLUTIONS

February 2001

SEMI F42 and F47 Voltage Sag Immunity Standards

What are the new SEMI Standards and how do they affect you?

Semiconductor Equipment and Materials International (SEMI) is a global trade association that represents the semiconductor and flat panel display equipment and materials industries. In an effort to learn how semiconductor equipment could be designed and modified to better tolerate storms and other voltage-sag events, a SEMI task group was formed. This group conducted comprehensive testing and research to analyze and resolve the problem. As a result of the analysis, SEMI F42 and SEMI F47, new standards for the semiconductor manufacturing industry, were established.

Storms and other causes of utility equipment failures result in voltage sags which can Affect the operation of sensitive production equipment, leading to shutdowns or malfunctions. If voltage sags cause equipment to shutdown or malfunction, the equipment is incompatible with its electrical environment. From the standpoint of the semiconductor fabrication electrical environment, the tool has poor system compatibility.

Voltage Sag Immunity Standards

SEMI has developed two voltage sag immunity standards.

- SEMI F47 sets out the required voltage sag tolerance for semiconductor fabrication equipment.
- SEMI F42 explains how to test compliance with SEMI F47.

In essence, SEMI F47 **requires** that compliant semiconductor processing equipment tolerate voltage sags on its AC power line. Specifically, it must tolerate sags to 50% of nominal for up to 200 ms, sags to 70% of nominal for up to 0.5 seconds, and sags to 80% of nominal for up to one second. In addition to these requirements, SEMI F47 **recommends** that equipment tolerate sags to 0% of nominal for one cycle, sags to 80% of nominal for 10 seconds, and continuous sags to 90%, but these are not part of the requirements.

SEMI F47 suggests that semiconductor manufacturers use this sag standard when procuring equipment. Major semiconductor manufacturers are beginning to take this approach.

SEMI F42 explains how to test compliance with F47. It describes safety procedures, processing modes, test sequences, phase connections, and reporting requirements.

SEMI F42 also distinguishes between testing equipment for "characterization" (determining the depth and duration of sags that equipment can tolerate) and "compliance" (a pass/fail test determining if equipment complies with the requirements and recommendations of SEMI F47).

Why does equipment fail when there are voltage sags on AC power systems?

1. *Equipment fails because there isn't enough voltage.* The DC stored in filter capacitors used in power supplies drops below some critical level. As a result, the regulators are not able to deliver their designed voltage and the system fails.
2. *Equipment fails because an undervoltage circuit trips.* Some designs include a circuit that monitors the AC power system for adequate voltage. Sags can exceed thresholds and the circuit shuts down the system.
3. *Equipment fails because an unbalance relay trips.* An unbalance relay used in three-phase systems is a device that shuts down the system if the phase voltage unbalance exceeds a certain threshold, typically a few percent.
4. *A quick-acting relay, typically in the Emergency Mains Off (EMO) circuit, shuts the system down.* If the relay used circuit operates quickly, it may interpret a brief voltage sag as an operator hitting the EMO switch. The whole system will shut down unnecessarily.
5. *A reset circuit may incorrectly trip at the end of the voltage sag.* Many electronic reset circuits are designed to operate at "power up" which may appear to occur at the end of a voltage sag. This can cause the system to reset itself.

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Solutions to increase voltage sag immunity

There are a number of solutions to increase voltage sag immunity.

The most obvious solution is to find the cause for the voltage sag and fix the problem. The exact cause can be found with a sag generator and acquisition system. Once the problem is identified, it is easier to fix. This process can be costly, not only in time and money, but also in engineering resources and even delays in getting product to market.

Listed below are a number of “quick-fixes” that can **increase immunity** to sags.

1. Switch power supply settings to a range that gives more breathing room with sags.
2. Connect single-phase power supply phase-to-phase, if it handles a range of 90 V to 250 V.
3. Reduce the load on the power supply or oversize them to achieve more ride-through.
4. Use three-phase supplies that are more tolerant to phase sags instead of single-phase supplies.
5. Run the power supply from a DC bus.
6. Change trip settings of unbalance relays, undervoltage relays, or internal reset protection circuits.
7. Slow the quick-acting relays down with a relay hold-in accessory or with a relay with more mass.

These quick-fixes may not completely solve the problem or the trade-offs may not be worth the effort.

A solution that **facilitates compliance** is to add an ONEAC UPS to the tool in question.

The UPS will provide clean, regulated, uninterruptible power to the load under all conditions. In addition, it ensures the tool will continue to operate during longer term sags, surges, or outages and allow for safe and orderly shutdown of the tool. If only compliance to F47 is required, a minimum battery configuration can be used with the UPS to minimize costs. Add more battery capacity as needed for tools requiring longer ride-through capability to finish the process, and/or to stop wafer damage and proceed with an orderly shutdown.

The high cost of downtime

The potential revenue loss from downtime in a semiconductor fabrication plant is enormous. In many stages of the semiconductor manufacturing process there is a high risk of wafer damage if a production tool is not shut down in an orderly fashion. Failure to achieve an orderly shutdown can result in hundreds of thousands of dollars in damaged wafers and lost production time. A UPS offers a very high return on investment (ROI) in a very short period of time.

An ONEAC UPS is a total solution that facilitates F47 compliance, prevents wafer damage and offers a high ROI. The tool manufacturer benefits by being able to offer a quick, all encompassing solution that facilitates compliance without the high cost of redesign efforts that may not work. In addition, the clean uninterrupted power supplied by an ONEAC UPS will increase the reliability and performance of the tool resulting in much lower service and maintenance costs. Semiconductor manufacturers are beginning to demand compliance to F47 because it makes good "economic sense". The new SEMI F42 and SEMI F47 standards are driving tool manufacturers toward compliance as evidenced by the large number using test labs to "characterize" their equipment.

An ONEAC Power Conditioner can also be added to the ONEAC UPS to give additional value to the solution by:

1. Stepping down international voltages to domestic voltages for tools only configurable for U.S. voltages.
2. Providing additional power conditioning in applications where a centralized UPS is located some distance from the tool.
3. Providing additional power conditioning for very sensitive loads.
4. Providing continuous power conditioning to the load in the event the UPS goes to bypass mode due to failure or for maintenance.

You can purchase copies of the F42 and F47 standards from SEMI (www.semi.org) for $50 each.