Voltage Sag Immunity Standards – SEMI F47 and F42 –

As you may already be aware, interruptions in manufacturing processes can be very costly….potentially millions of dollars in revenue per day. Such interruptions can be due to voltage sag events which are the most important power quality problem facing many industrial customers, especially those with a process.

A voltage sag is defined as a decrease in voltage magnitude below 90% of nominal, but not a complete interruption. The typical duration is from 3 to 10 cycles or 50 to 167 milliseconds. The results from a Distribution Power Quality (DPQ) project prepared by the Electric Power Research Institute – Power Electronics Applications Center (EPRI-PEAC) concluded that a typical customer could on average experience 12 voltage sags per year from the utility.

Voltage sags caused by severe weather conditions, car pole accidents, utility equipment operations or failures, and adjacent customers are beyond your control. However, voltage sags caused internally in your facility can be resolved using different mitigation techniques before implementing the following standards. To help improve the robustness or voltage sag ride-through capabilities in the procurement of new equipment and improvements in equipment system design, the industry association for the semiconductor industry known as Semiconductor Equipment and Materials International (SEMI) has developed the following two voltage sag immunity standards.

1. ***SEMI F47-0200,*** *Specification for Semiconductor Processing Equipment Voltage Sag Immunity.* Specifies the required voltage sag tolerance for semiconductor fabrication equipment.

2. ***SEMI F42-0600****, Test Method for Semiconductor Processing Equipment Voltage Sag Immunity.* Explains the method on how to test compliance with SEMI F47.

SEMI F47 requires that semiconductor processing equipment tolerate voltage sags connected onto their AC power line. They must tolerate sags to 50% of equipment nominal voltage for duration of up to 200 ms, sags to 70% for up to 0.5 seconds, and sags to 80% for up to 1.0 second. These requirements are defined by values shown in ***Table 1.***

VOLTAGE SAG DURATION				***VOLTAGE SAG***
Second (s)	Milliseconds (ms)	Cycles at 60 hz	Cycles at 50 hz	Percent (%) of Equipment Nominal Voltage
<0.05 s	<50 ms	<3 cycles	<2.5 cycles	Not specified
0.05 to 0.2 s	50 to 200 ms	3 to 12 cycles	2.5 to 10 cycles	50%
0.2 to 0.5 s	200 to 500 ms	12 to 30 cycles	10 to 25 cycles	70%
0.5 to 1.0 s	500 to 1000 ms	30 to 60 cycles	25 to 50 cycles	80%
>1.0 s	>1000 ms	>60 cycles	>50 cycles	Not specified

Table 1- Voltage Sag Duration and Percent Deviation from Equipment Nominal Voltage

Figure 1 is a required voltage sag ride-through capability curve in which semiconductor processing, metrology, and automated test equipment must be designed and built to conform. The equipment must be able to continuously operate without interruption during conditions identified in the area above the defined solid black line.

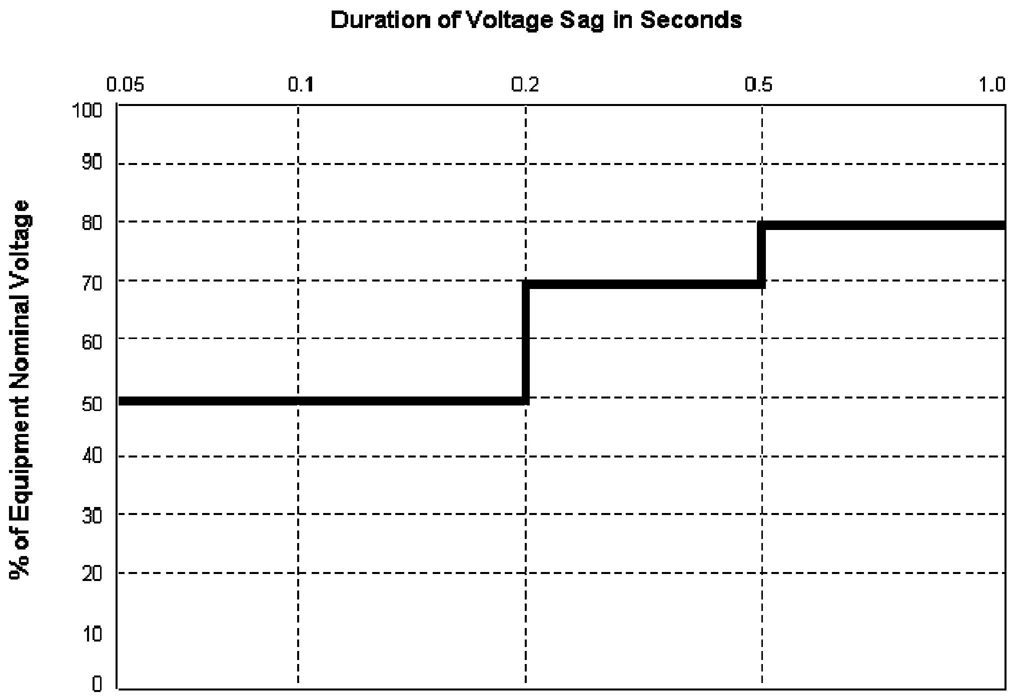

Figure 1- Required Semiconductor Equipment Voltage Sag Ride-Through Capability Curve

Note: Equipment must continue to operate without interruption during voltage above the line.

There are additional thresholds recommended by SEMI F47 but are not requirements of the standard. These include that equipment tolerate sags to 0% for 1.0 cycle, sags to 80% for 10 seconds, and continuous sags to 90% as shown in ***Figure 2.***

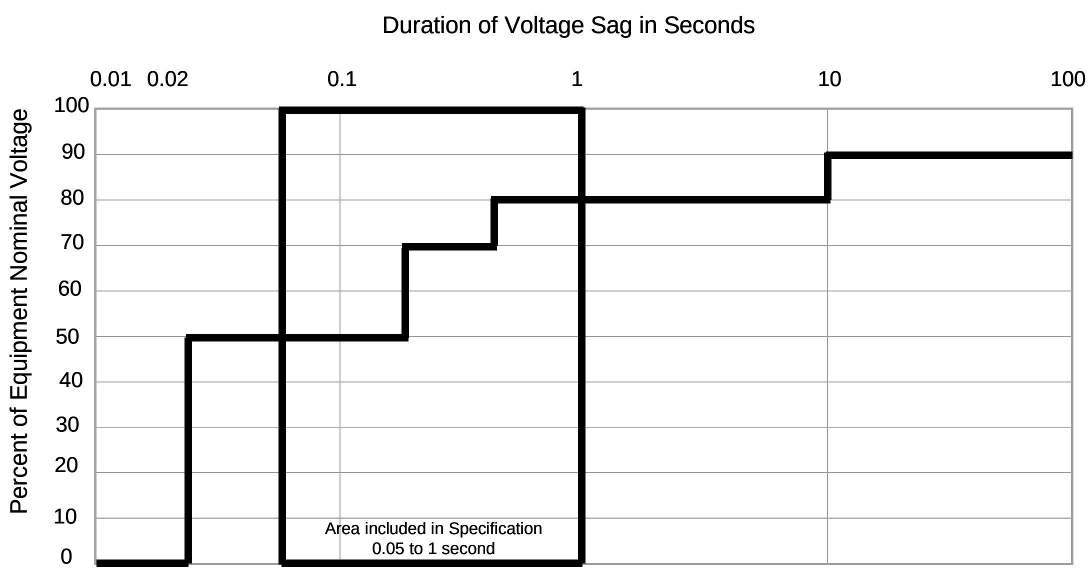

Figure 2 - Recommended Semiconductor Equipment Voltage Sag Ride-Through Capability Curve from 0 to 100 Seconds

For New Equipment:

SEMI F47 suggests that semiconductor users may use this sag standard when procuring new equipment to specify the capability of equipment ride-through requirements to the equipment manufacturer. In addition, semiconductor processing equipment manufacturers may in turn specify ride-through requirements to component and module suppliers.

SEMI F42 defines the testing procedures and test equipment required to characterize the susceptibility of equipment to voltage sags by showing voltage sag duration and magnitude performance data for the equipment. Also, it describes safety precautions, processing modes, test sequences, phase connections, reporting requirements, and determining compliance with the requirements and recommendations of SEMI F47.

For Existing Equipment:

There are several third-party consultants that can come into a customer's facility and conduct a thorough investigation of equipment immunity to voltage sags and momentary interruptions. Portable instrumentation such as a sag generator, are designed specifically to test compliance with SEMI F47 and SEMI F42 standards for equipment ride-through of voltage sags. Therefore, process vulnerabilities and weak elements can be determined with the creation of an electrical disturbance in the power that supplies critical process equipment.

There are several simple ways in which you can increase voltage sag immunity yourself. The best place to start is to find and fix the problem. Once you know what the problem is, it will be much easier to fix. The following are examples of simple corrections that can be implemented to help increase voltage sag immunity –

1. **Switch power supply settings.** Many power supplies can be set to accommodate different voltage ranges. Choose a range where your nominal voltage is near the top of the range to allow more room for voltage sags.

2. **Connect your single-phase power supply phase-to-phase.** You can get a 70% margin in available voltage by connecting phase-to-phase, if you can stay within your power supply's acceptable voltage range and have three-phase power available.

3. **Reduce the load on your power supply.** If you can determine that a particular power supply is causing your equipment to misoperate during voltage sag, consider moving some of its loads to another power supply.

4. **Increase the rating of your power supply.** If you can not move the loads, use a larger supply for the same load relative to its rating. It will then be more lightly loaded.

5. **Use a three-phase power supply instead of a single-phase power supply.** A properly designed (and lightly loaded) three-phase power supply will effectively tolerate voltage sags on one or two phases that would shut down a single-phase power supply.

6. **Run your power supply from a DC bus.** If possible, substitute a DC-operated power supply for an AC-sourced supply. This will narrow down your problems to supporting a DC bus, which can often be done with simple capacitors or batteries.

7. **Change the trip settings.** If you can identify an unbalance relay, an under voltage relay, or an internal reset or protection circuit that is inadvertently tripping during a voltage sag, change its settings. Consider changing the threshold and/or the trip delay. This solution resolves trip settings set too conservatively to begin with. However, trips are useful and important so use good judgment as to not eliminate them completely.

8. **Slow the relay down.** Use a relay with more mechanical mass, such as a contactor or use a relay hold-in accessory.

9. **Get rid of the voltage sag itself.** As a last resort, consider installing a quick-operating voltage regulator on your AC supply. There are a variety of technologies including ferro-resonant transformers, solid-state voltage compensation, etc. Be careful not to make the problem worse if the original cause of the voltage sag is downstream from your voltage sag regulator. The voltage sags will actually get deeper and longer.

For additional information on voltage tolerance relating to these standards, please see our Power Note titled **Voltage Tolerance Boundary:**
http://www.pge.com/includes/docs/pdfs/biz/power_quality/power_quality_notes/voltage_tolerance.pdf.