SEMI F50-0200 (Reapproved 1213)
GUIDE FOR ELECTRIC UTILITY VOLTAGE SAG PERFORMANCE FOR SEMICONDUCTOR FACTORIES

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NOTICE: This Document was reapproved with minor editorial changes.

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1 Purpose

1.1 This Guide provides a framework for semiconductor and flat panel display (FPD) manufacturers and their electric utility service providers to minimize the effect of voltage sag events on semiconductor processing. In particular, this Guide focuses on electric utility power quality performance goals that are complementary to voltage sag immunity levels for semiconductor processing equipment and facilities infrastructure equipment (see Figure 1). Recommendations for measuring and evaluating voltage sag performance, evaluating utility system enhancements, and implementation of a continuous improvement process are included since no electric utility industry standards exist.

1.2 Utility systems are designed, constructed, and operated to meet utility industry regulations and requirements. One important requirement for semiconductor factories is power system reliability. Utilities measure reliability in minutes of voltage outages per customer per year. Semiconductor factories require a high level of power system reliability, any service outage is usually unacceptable. A second important requirement is power quality. Power quality relates to disturbed voltage waveforms, not outages. When utilities implement measures to increase power system reliability, power quality can be adversely affected. The structured approach defined in this Guide can achieve high levels of power quality without sacrificing power reliability.

1.3 The intent of this Guide is to help semiconductor manufacturers achieve both high levels of power reliability and power quality from energy utility providers. By becoming familiar with the cause and effect relationships of voltage sag events on the utility's side of the electric meter, semiconductor manufacturers and electric utilities can work together to pursue efficient solutions for improved voltage sag ride-through in semiconductor factories.

2 Scope

2.1 The scope of this Guide extends beyond a discussion of typical electric utility reliability and quality improvement techniques to developing a continuous improvement process for electric utility voltage sag performance (depicted graphically in Figure 2). Factors in this process include the following:

- Define desired performance criteria by setting goals for voltage sag event duration and magnitude (see ¶ 6.1).
- Measure performance for both proposed and existing semiconductor factory sites (see ¶ 6.2).
- Summarize voltage sag event data and identify the impact on semiconductor processing and facilities infrastructure equipment (see ¶ 6.3).
- Recommend improvements that include consideration of cost, benefit, and risk. Improvements can include corrective action to eliminate system faults, changes to service configurations, and power enhancements (see ¶ 6.4).
- Select and implement improvements. Establish a continuous improvement process (see ¶ 6.5).

2.2 For the purposes of this Document, the term Electric Utility refers to energy service providers (that sell energy to semiconductor manufacturers) and/or electric transmission and distribution providers (that deliver energy through their power lines).

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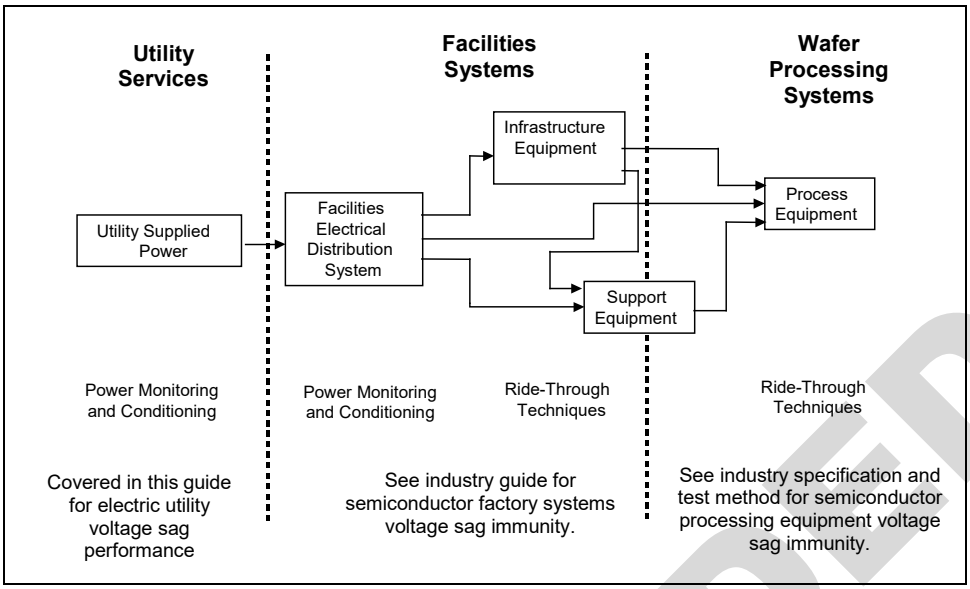

Figure 1
Power Quality Interfaces
(See Related Documents section.)

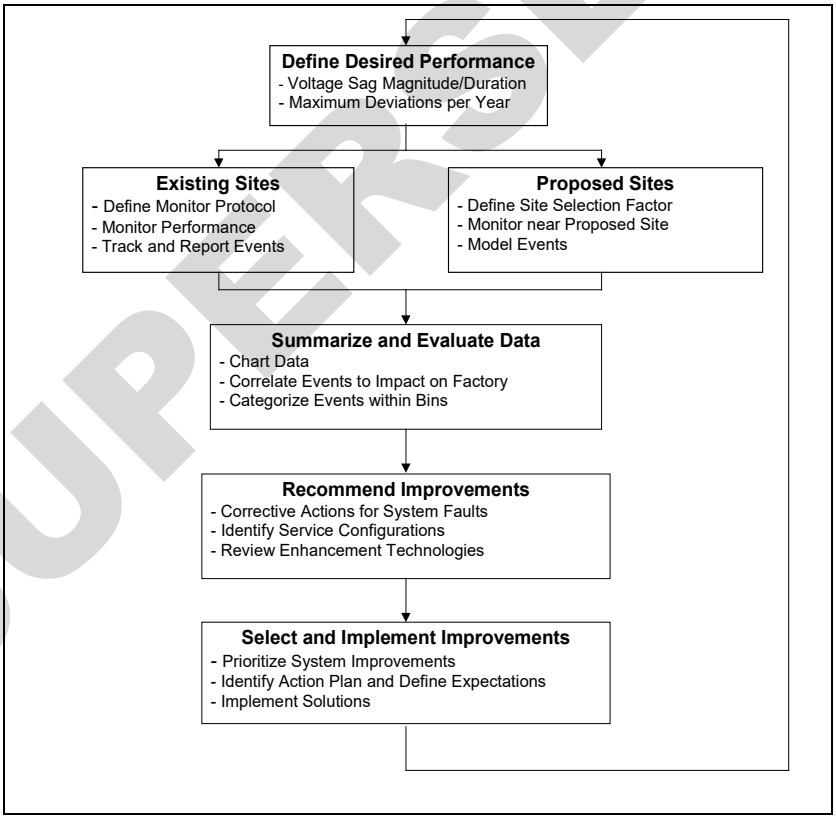

Figure 2
Continuous Improvement Process

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3 Limitations

3.1 This Guide addresses electric utility power quality monitoring and enhancement techniques primarily related to semiconductor factory energy utility providers. Process equipment and factory systems are covered in other related standards.

3.2 This Guide is not intended to address design or materials issues related to safety which are addressed elsewhere in SEMI Safety Guidelines (see SEMI S2).

3.3 This Guide is not intended to supersede international, national or local codes, regulations and laws. Each should be consulted to ensure that the equipment meets regulatory requirements in each location.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI S2 — Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment

4.2 *IEEE Standards*[1]

IEEE 1159 — IEEE Recommended Practice for Monitoring Electric Power Quality

IEEE 1250 — IEEE Guide for Service to Equipment Sensitive to Momentary Voltage Disturbances

IEEE 1346 — IEEE Recommended Practice for Evaluating Electric Power System Compatibility with Electronic Process Equipment

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 *Definitions*

5.1.1 *electric utility* — the company identified as the contractual provider of electrical power and energy to the customer point of delivery. Also known as the electric service provider.

5.1.2 *voltage sag* — an rms reduction in the ac voltage at power frequency for durations from half-cycle to a few seconds (see IEEE 1250). Also known as voltage dip.

6 Electric Utility Voltage Sag Performance Recommendations

6.1 *Define Voltage Sag Performance*

6.1.1 Defining a goal for acceptable voltage sag duration and magnitude is useful in establishing a benchmark or reference point for monitoring improvement. Events can be identified and categorized within the realm of the electric utility or the semiconductor manufacturer. Industry specifications for semiconductor processing equipment voltage sag immunity (which define the level of voltage sag immunity required for semiconductor processing equipment) are recommended as a performance goal. Using this goal for the performance of electric utility services will provide consistency with semiconductor processing equipment capabilities. (See Related Documents section.)

6.1.2 The goal for the maximum number of deviations from specified performance per year is zero. However, it is useful to recognize that utility generation, transmission, and distribution systems are subject to environmental and regulatory conditions that may negatively influence the ability to provide zero deviations on a continuous basis.

6.1.2.1 Document regulatory and environmental requirements that will limit the electric utility's choices when implementing improvements, such as rate structures or rights-of-way.

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6.2 *Measure Performance*

6.2.1 *Measuring Performance at Proposed Semiconductor Factory Sites*

6.2.1.1 Factory site selection teams should consider the importance of power and power quality when evaluating potential sites. To ensure that power quality considerations are properly factored into the site selection process, a selection factor should be assigned to power quality and reliability criteria.

6.2.1.2 Utility electrical service configurations should be considered when measuring and comparing reliability and power quality performance at different locations. The load profile for the proposed factory is used to determine the standard utility electrical service configuration. Usually, larger factories (>10 MW) exceed allowable loading for lower voltage distribution systems (<69 kV), therefore a high voltage service is the typical configuration for larger semiconductor factories. Selection of the highest available service voltage is preferred for reliability due to two factors. First, the area of exposure is greater for lower voltages since they include both higher and lower voltage system distribution lines and equipment. Second, higher voltage systems can provide energy to lower voltage system faults with little or no impact to high voltage system voltages, whereas, lower voltage systems are greatly impacted by faults not buffered by transformers.

6.2.1.3 The preferred method for comparing power quality and reliability from different locations involves creating a summary of the number of voltage sag events that fall into different magnitude-duration categories. Data from different categories should be adjusted by weighting factors to enable valid comparison. See IEEE 1346 for suggested voltage sag event category and weighting factors.

6.2.1.4 *Model Events*

6.2.1.4.1 If actual disturbance data is not available, modeling results based on simulation of actual electrical faults should be calculated and reviewed. These studies called area of vulnerability analysis determine transmission lines and equipment where faults can adversely impact a semiconductor factory.

NOTE 1: As monitoring data is later collected, the modeling results should be validated.

6.2.1.5 Monitor events near proposed site(s).

6.2.1.5.1 Define monitoring protocol per the method outlined in § 6.2.2.2.

6.2.1.5.2 Upon establishing an appropriate electrical service configuration, reliability and power quality information relative to that service configuration should be requested from the electric utility. Depending upon utility rate structures, semiconductor manufacturers may be required to pay separately for this analysis. Where available, the information provided should include actual disturbance data from other selected sites collected in accordance with IEEE 1159. Strive for data on sites that have similar electrical service configurations and are located electrically close to the proposed site (e.g., ideally, from the same transmission or distribution line).

6.2.2 *Measuring Performance at Existing Semiconductor Factory Sites*

6.2.2.1 *Preparation for Monitoring*

6.2.2.1.1 Review existing industry typical voltage sag performance data for utility point-of-service.

6.2.2.1.2 Review existing site voltage sag performance data, usually taken at a variety of locations within the factory.

6.2.2.1.3 Review existing utility voltage sag performance data for the area around the factory site, usually a 20 to 30 mile radius of the service area is sufficient.

6.2.2.1.4 Review existing utility area of vulnerability modeling studies for power flow and system power quality.

6.2.2.1.5 Document the existing utility and manufacturing site electrical design and operating procedures.

6.2.2.2 *Define the Monitoring Protocol*

6.2.2.2.1 Define where measurement devices will be located, how many to be installed, who will operate and maintain them, and what are the standards for calibration.

6.2.2.2.2 Define sensitivity settings. Usually magnitude triggers are set as tightly as possible (95% of nominal voltage). This will generate a large amount of data that will verify trends and maximize comparison opportunities between cause and effect. After several evaluation cycles magnitude triggers can be moved closer to the criteria (90% of nominal voltage), in order to focus improvement efforts on the more significant sags.

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