

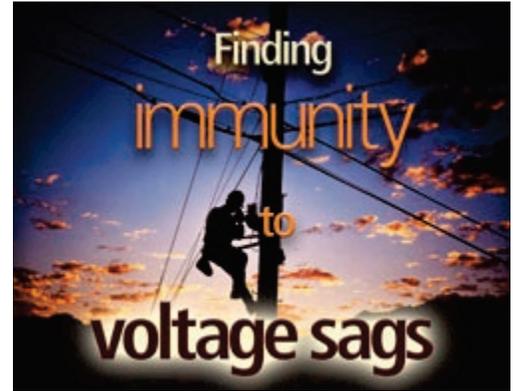
## Finding Immunity to Voltage Sags

By Mike Johnson

*This article originally appeared in the December 2004 issue of Electrical Business, a CLB Media Group Magazine.*

One of the most frequent power quality disturbances is not a complete loss of power but rather a short loss of line voltage. Known as 'voltage sag', this often underestimated and overlooked event accounts for a significant portion of lost revenue due to equipment damage and production downtime. In the blink of an eye, sags in voltage can bring production to a halt.

A study conducted by the Electrical Power Research Institute (EPRI) using data collected over a three-year period concludes that, on average, nine sags occur for every power interruption. We know voltage sag is occurring when the lights appear dimmer. Not a big deal, but to automation equipment, sags can mean equipment shutdown, loss of data and inexplicable resets.



Sags can stress components over time, resulting in premature wear and failure. For processes relying on high speed, any interruption can lead to significant production shortages. Interruptions to processes requiring hours to create one part or a single batch of parts have a significant impact on company profits. Shutdowns result in scrapped work, production shortages, lower service levels for customers and less income for the company. Fortunately, there are ways to prevent sags from disrupting operations.

### Protecting Production

The easiest way to protect against short-term voltage sags is to employ power-conditioning devices for regulating and protecting power. Several such technologies exist, including constant-voltage transformers, three-phase power conditioners and uninterruptible power systems. The alternative to adding these mitigating devices to production equipment involves purchasing and designing equipment to tolerate sags, and while this approach does require more planning, it ultimately lowers overall system costs.



Figure 1

Many manufacturing and process industries focus on preventing/mitigating sags to maintain maximum competitiveness, productivity and quality. The Semiconductor Equipment and Materials Institute (SEMI) has gone so far as to establish a minimum standard with regard to sag immunity performance for semiconductor tools and equipment. The SEMI F47 standard introduces a well-conceived, voltage-to-time curve to which most equipment will be exposed during normal operation. SEMI has also developed a specific method for testing and reporting.

The curve in Figure 1 depicts the minimum hold-up time in seconds (X axis) relative to the percentage of normal line voltage (Y axis). SEMI F47 specifies equipment must be able to tolerate 50-per cent line voltage for 200 ms, 70-percent line voltage for 500 ms and up to one second for 80-percent line voltage.

And while there is nothing stopping you from surveying your own facility and developing your own standard, using SEMI F47 saves considerable time and effort. More information on this standard can be found online at [www.semi.org](http://www.semi.org).

Several third-party, independent laboratories can test for conformance with SEMI F47's sag immunity requirements. This means that regardless of the industry being served, there is a system in place you can use to ensure the products you purchase can handle the sags to which they will be subjected during normal operation. The first step is to identify which components are critical to machine operation and would be adversely affected by voltage sag.

## Identifying the Sensitive Types



Most motors, lighting and indicators can tolerate sags of short duration with negligible detriment to production (perhaps a fan slows down briefly or a light flickers, but production goes on). The most sag-sensitive, and usually most critical, component is the AC/DC power supply used to power all DC control and logic circuits.

Any type of computing or automation equipment must use an AC/DC power supply to supply the right power level for chips and components. The majority of power supplies on the market currently averages 10 ms to 20 ms of hold-up time at full load. These devices will not meet the sag immunity performance needed to work during common sag events without special considerations undertaken by the system designer.

One consideration is to use a universal input power supply (85 VAC to 264 VAC) and power from the higher line voltage (208/240 VAC). This, of course, only meets the needed level of performance when powered from the higher line voltage. Operating from 208 VAC or 240 VAC is not always practical or possible. After all, the most popular input line voltage in North America is 120 VAC.

Another option is to de-rate the power supply to a lower output current in the hopes that it performs better when exposed to input sags. This option relies on the designer to test and verify no loads are added that would carry the power supply above the level at which it meets the performance standard. This method is risky, as any rework or modifications after initial design could make the system susceptible to input sags.

The preferred method is to employ a power supply meeting SEMI's standard at full power and all voltage ranges. This gives the designer maximum flexibility with minimum design effort. Look for manufacturers who offer third-party tested, SEMI F47-compliant power supplies, or pay to have your current supplies tested to ensure they offer trouble-free operation in all environments.

### Notes

1. For more information on the EPRI DPQ study, visit [www.epri.com](http://www.epri.com).
2. SEMI F47-0200, Specification for Semiconductor Processing Equipment Voltage Sag Immunity.

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