PQSoft Case Study

Improving Equipment Ride Through
Voltage Sag Evaluation

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Abstract:

Voltage variations, such as voltage sags and momentary interruptions are two of the most important power quality concerns for customers. Customers understand that interruptions cannot be completely prevented on the power system. However, they are less tolerant when their equipment mis-operates due to momentary disturbances which can be much more frequent than complete outages. Voltage variations and interruptions are inevitable on the power system. The most important of these variations occur during fault conditions on the power system.

This case presents the results of measurements and analysis of the impact of voltage sags on a process controller.

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RELATED STANDARDS

IEEE Standard 1159

GLOSSARY AND ACRONYMS

CVT	Constant Voltage Transformer
CBEMA	Computer and Business Equipment Manufacturers Association

PROBLEM STATEMENT

A semiconductor manufacturer was experiencing problems with large motors tripping off-line during voltage sag conditions. If enough motors trip off-line, the entire manufacturing process can be disrupted resulting in significant lost revenue.

PLANT VOLTAGE DURING FAULT

The voltage sags were being caused by faults on the utility's distribution system. These faults were caused by tree limbs, squirrels, accidents, etc. These faults caused a short circuit at the fault location and resulted in depressed voltages during the fault and until protective devices operated to clear the fault.

A BMI 8010 power quality disturbance analyzer was placed at the plant service entrance to record the power quality. Figure 1 is an example of a voltage sag measured at the plant that resulted in dropout of the motors.

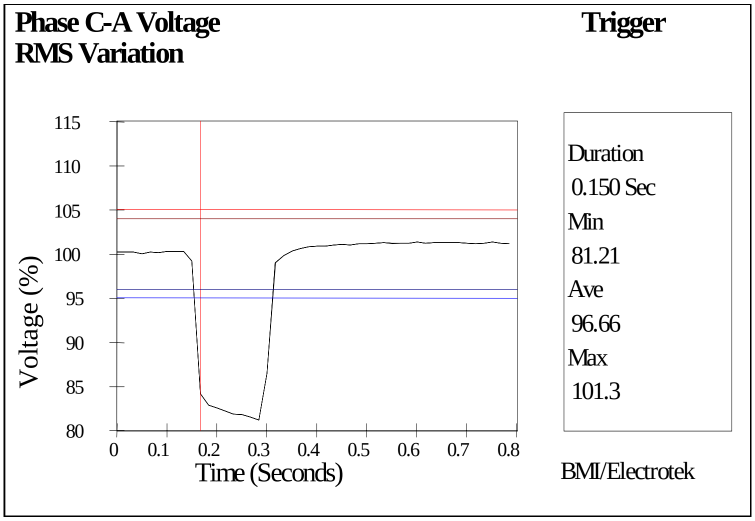

Figure 1 - Plant Voltage during Fault

EVALUATING EQUIPMENT SENSITIVITY

A process controller was thought to be causing the motors to trip off-line. A voltage sag simulator was used to test the ride through capability of the temperature controller for voltage sags from 0.5-1000 cycles in duration. The controller was found to very sensitive to voltage sags, tripping at approximately 80% of nominal voltage regardless of duration (Figure 2). The controller was found to be more sensitive than the CBEMA (Computer and Business Equipment Manufacturers Association) curve for sags up to approximately 40 cycles in duration.

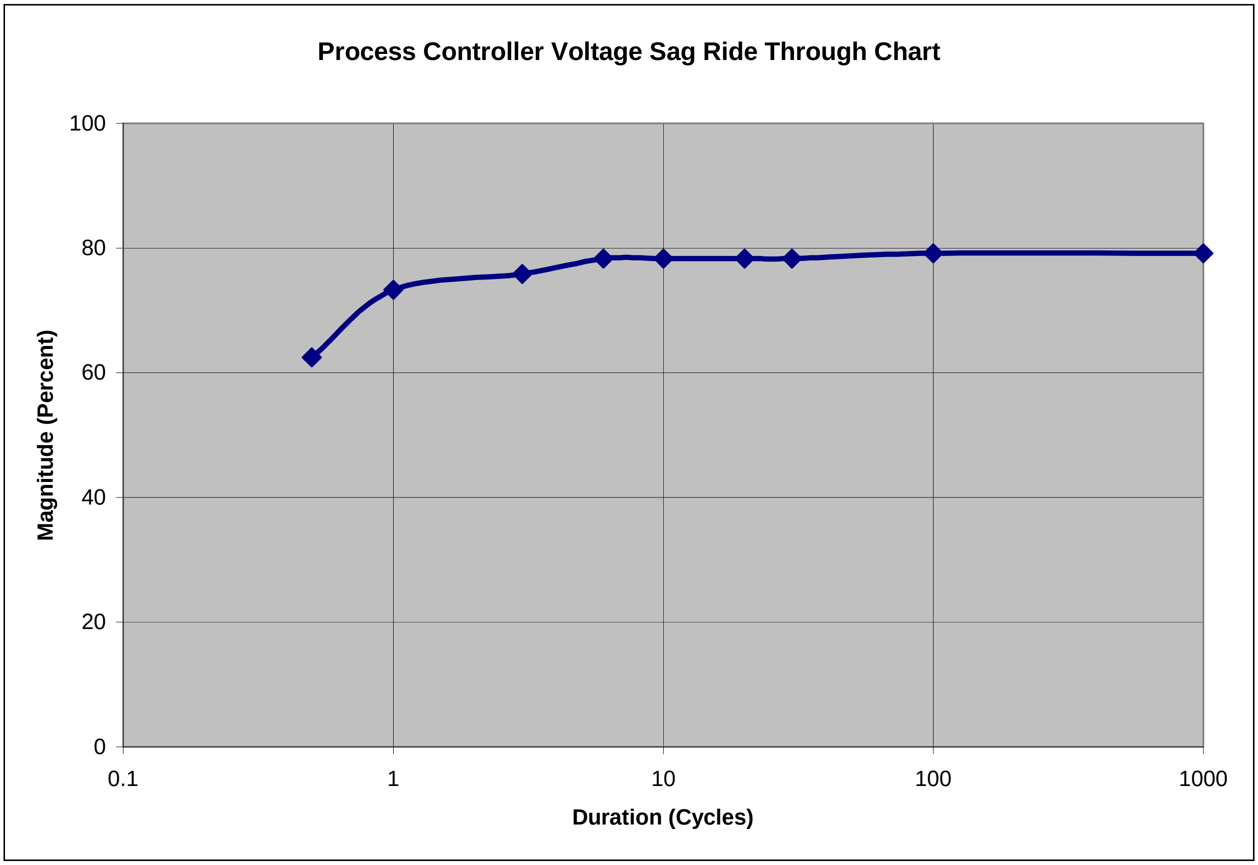

Figure 2 - Process Controller Ride-Through Capability

DETERMINING A SOLUTION

A ferroresonant or constant voltage transformer (CVT) was obtained to determine if it could improve the ride through capability of the temperature controller. CVTs work similar to a transformer being excited high on its saturation curve, so that the output voltage is not significantly affected by input voltage variations. CVTs are especially attractive for loads with relatively low power requirements and are constant. The process controller, now powered through a 120 VA CVT, was tested again. Voltage sags up to 1000 cycles in duration and down to 30% of nominal voltage did not affect the controller (Figure 3).

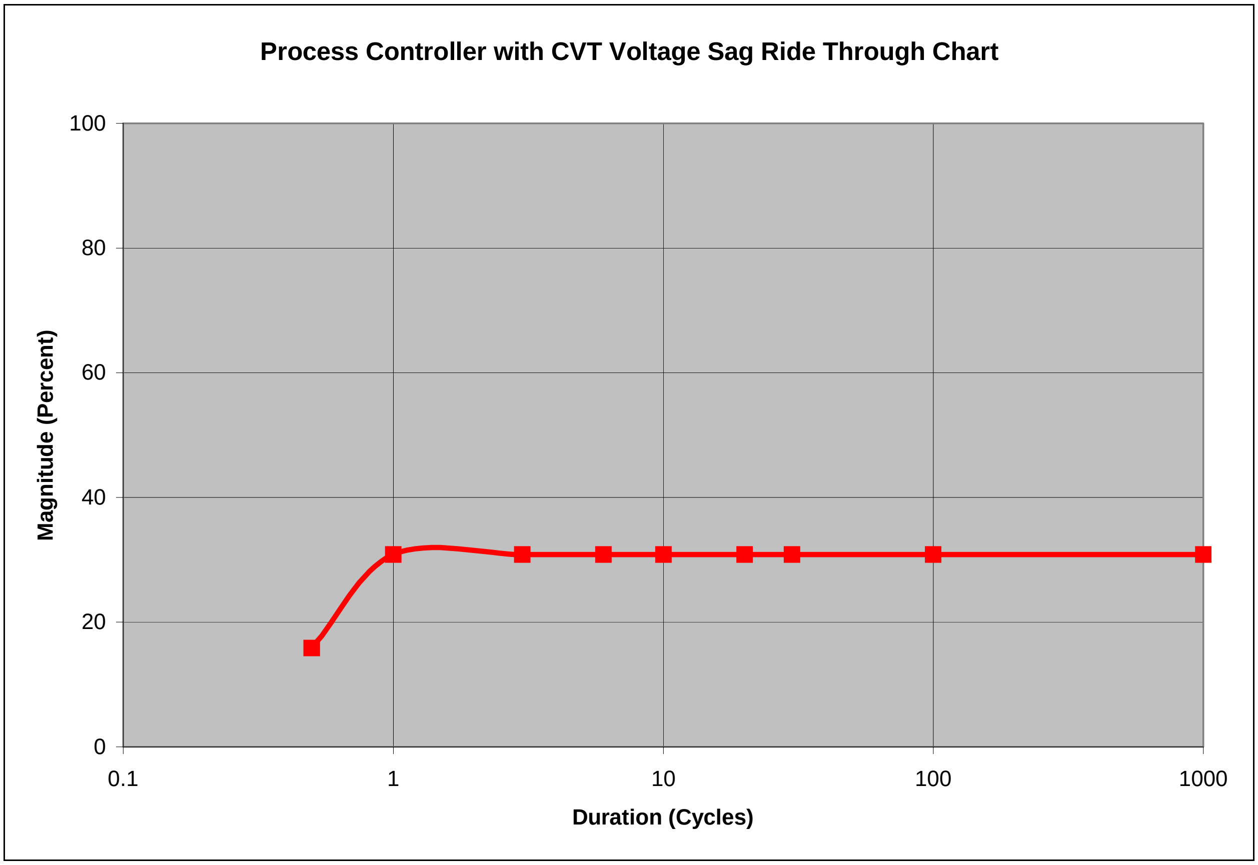

Figure 3 - Improved Ride-Through with CVT

To obtain ride through down to about 50% of nominal voltage, the CVT must be oversized, to approximately twice the size of the protected load. The output voltage of a CVT collapses to zero during a complete outage.

The disturbance analyzer was used to determine the performance characteristics of the CVT. Figure 4 shows a voltage sag recorded at the CVT input. No disturbance was triggered on the CVT output. Figure 5 shows the corresponding 24-hour strip chart for the CVT input and CVT output. The input strip chart clearly shows the voltage sag, while the output was very clean.

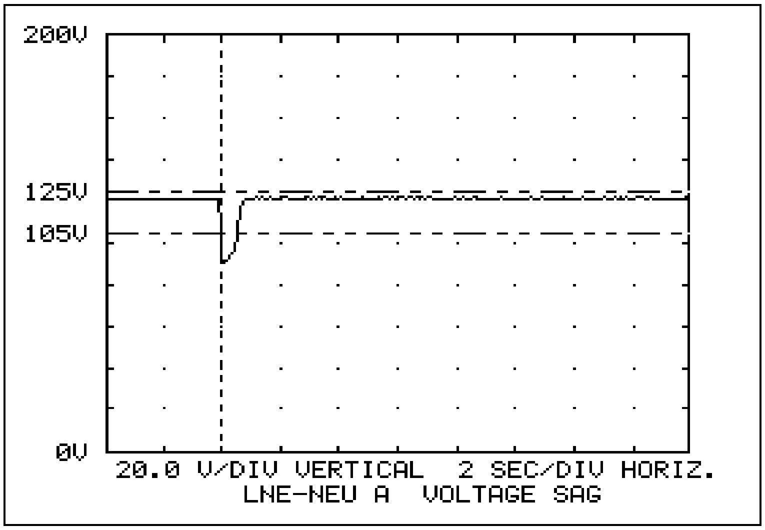

Figure 4 - Measured Voltage Sag at Input of CVT

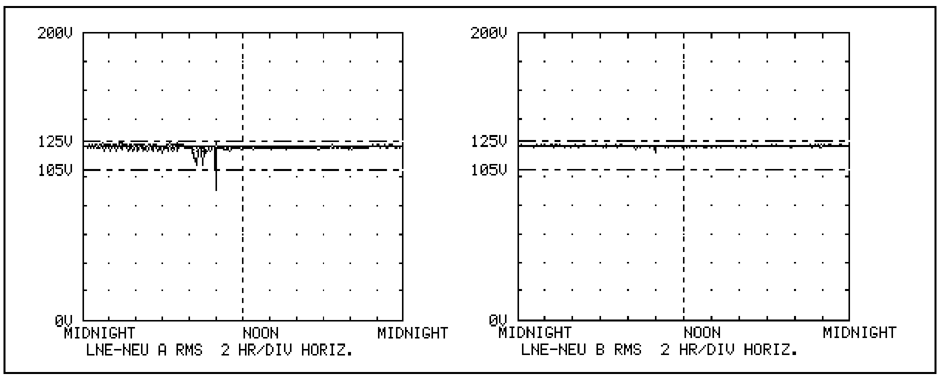

Figure 5 - CVT Input and Output Strip Charts

Note: The dashed line in Figure 4 indicates the trigger point of the event and does not correspond to the dashed line in Figure 5. The event illustrated in Figure 4 can be seen just to the left of the dashed line in Figure 5.

SUMMARY

Voltage variations, such as voltage sags and momentary interruptions are two of the most important power quality concerns for customers. Customers generally understand that interruptions cannot be completely prevented on the power system. However, they are less tolerant when their equipment mis-operates due to momentary disturbances that can be much more frequent than complete outages. These conditions are characterized by short duration changes in the rms voltage magnitude supplied to the customer. The impact to the customer depends on the voltage magnitude during the disturbance, the duration of the disturbance, and the sensitivity of the customer equipment.

Voltage variations and interruptions are inevitable on the power system. The most important of these variations occur during fault conditions on the power system. Since it is impossible to completely eliminate the occurrence of faults, there will always be voltage variations to contend with. Power quality complaints occur either when the customer has equipment that is very sensitive to these voltage sags and is critical to the overall process or when the frequency of occurrence of the interruptions or sags is interpreted as being unacceptable.

REFERENCES

M. McGranaghan, D. Mueller and M. Samotyj, “Voltage Sags in Industrial Systems,” IEEE Transactions on Industry Applications, Vol. 29, No. 2, March/April 1993.

J. Lamoree, J.C. Smith, P. Vinett, T. Duffy, M. Klein, "The Impact of Voltage Sags on Industrial Plant Loads," First International Conference on Power Quality, PQA'91, Paris, France.

G. Beam, E.G Dolack, C. J. Melhorn, V. Misiewicz, M. Samotyj, "Power Quality Case Studies, Voltage Sags: The Impact on the Utility and Industrial Customers," Third International Conference on Power Quality, PQA '93, San Diego, CA, Nov 1993.