

Power quality

Measurements and solutions

At a glance

Power quality related problems, such as harmonic distortion or voltage dips, are coming to the forefront for utilities, as well as for industry. The cause of the problems and the optimum solutions vary substantially from case to case.

Siemens Power Technologies International (Siemens PTI) can consult on all aspects regarding power quality to determine the best possible solution for any network. Working with Siemens PTI you can expect:

- concepts for individual power quality solutions to specific needs
- full-range service: Siemens PTI performs both measurements and simulations
- long-term consulting and support

The challenge

Whether it is a public power supply network, an industrial plant or a wind farm, harmonics, switching surges or voltage dips can have serious effects on power quality. In many cases, the cause of a problem cannot be detected immediately. It is either a temporary phenomenon that only occurs occasionally or it leads to a slow degradation of insulating materials with outages to follow after months or even years. It must be decided on a case-by-case basis on how best to address the problem. Significant experience gained from a variety of previously analyzed disturbances is required to find the optimum solution.

For plants and systems under development, it might be necessary to determine, in advance, if certain network and load limits, e.g. on harmonics or voltage dips, will be met easily or if special measures need to be taken. Proper modeling of complex systems is needed to obtain results that are as close to reality as possible.

Our solution

Siemens PTI offers a full spectrum of consulting services around power quality, starting from measurements in existing state and calculations for future plants, as well as the optimum mitigation measures to ensure a stable and trouble-free operation of the network. Siemens PTI's long-term experience in the investigation of outages and disturbances ensures that we will find the cause of the majority of problems caused by power quality related disturbances. Siemens PTI also supervises the installation of mitigation measures or assists during technical discussions with suppliers or clients, if required.

We are the partner to provide a tailor-made concept for our customers' unique problems. After defining the specific task, we carry out pertinent measurements to track down the cause of a certain disturbance. We can also model a system in our specialized computer software to understand the behavior of any given network.

Detailed implementation proposals are given for measures necessary to operate the respective system, trouble-free in the future. This could be the instal-

lation of equipment, such as harmonic filters. In some cases, the problem can be solved simply by rearranging the supply system and the loads. Our consulting services cover the entire process until the measures are implemented.

Measurements

The duration of measurements can range from spot measurements, up to a long-term surveillance of a certain node over a period of several months. The results are typically used for clearing outages, identifying a system's condition and verifying adherence to guarantee values.

We measure the following power quality related quantities:

- flicker: power oscillations, rapid load fluctuations, e.g. in rolling mills, welding plants, etc.
- power frequency phenomena: active and reactive power flow and power factor
- current and voltage harmonics: harmonics in 50 and 60 Hz networks up to the 50th harmonic (2,5/3 kHz), total harmonic distortion (THD)
- voltages and currents above the 50th harmonic caused by modern PWM converters
- interharmonics
- ripple control signals

A precise evaluation of the measurements and detailed explanations of the effects can be seen on the measurement plots. Proposals are given detailing how to proceed to fix the problem and to ensure that all limits imposed will be met.

Simulations

Fault analysis

Fault analysis often starts with measurements, but it is rarely finished after the measuring devices are disconnected again. Firstly, it is often impossible to clarify faults using standard instruments. Secondly, interpreting the measurements and data acquired – and deciding on suitable remedies – calls for relevant expertise. In some cases, time or frequency domain calculations have to follow in order to prove the efficiency of the mitigation measures. In all cases, Siemens PTI is involved in the process as long as support is required.

Harmonic filter design

The connection of powerful converters, such as large variable speed drives or electrolysis rectifiers, to medium- or high-voltage networks requires the connection of filter circuits for harmonic mitigation and power factor correction. Detailed knowledge of the converter, as well as the underlying process, is necessary to find a technically satisfactory and cost-efficient solution.

Concepts for reactive power compensation

Implementation of power factor correction equipment on all voltage levels requires a detailed consideration of harmonic issues since the capacitors

used typically change the resonance behavior of the subsystem significantly. Based on load flow calculations, we provide solutions for reactive power compensation schemes, even for complex plants, that are cost-effective, consider all operating conditions and avoid any harmonic problems. Rating of the equipment and preparation of specifications are included in our service, if needed.

Application example

During the commissioning of a combined cycle power plant (CCPP), drives fed by low-voltage converters were tripped during the start-up sequence via starting converter. The task was to identify the main cause for the disturbances by means of measurements and propose a suitable countermeasure.

Measurements were performed to identify the probable cause for this disturbed operation of the low-voltage converter (LVC). Then, a principal simulation model of the system configuration was built. Both, the measurement and the simulation results, showed a considerable amount of high-frequency content in the voltage due to commutation of the starting converter and excitation rectifier. The parallel resonance caused by cable capacitances and feeding impedance at the 6.6 kV level was excited to perform damped oscillations at each single commutation (see figure 1).

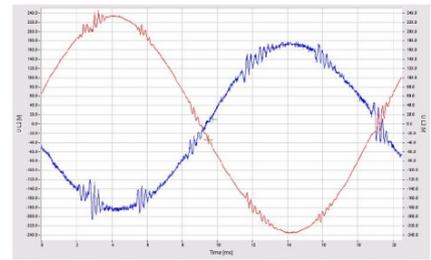


Figure 1: Measurement (red line) and calculation (blue line) of line-to-line voltage at MV bus

A highly probable cause for LVC shutdown consisted of an overvoltage of the internal DC voltage. The DC circuit of the LVC was equipped with a chopper, including a breaking resistor. The corresponding resistor was specified for time-limited, regenerative operation of the drive – not for reduction of system overvoltages. It was protected against overheating by a security shutdown of the LVC. It could be simulated that this security shutdown will occur in the operation at the weak system, whereas in operation at the normal system there is a sufficient safety margin to this security shutdown.

Installing an additional 2 percent choke at the feeding terminal of the LVC improved the operating conditions at the weak feeding system so that tripping will not occur.

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