CHAUVIN ARNOUX

Power Quality Issues - Part 2 - Dips and Swells

Continuing on from the previous article on the issues of harmonics within an electrical installation, this month **Julian Grant – General Manager at Chauvin Arnoux UK,** discusses the symptoms and effects of dips and swells on the electrical network, and steps that can be taken to mitigate any problems.

When a subscriber purchases electrical energy, they are effectively buying a product. Like any other product it needs to meet the necessary prescribed quality standards to ensure it works properly, or in the case of electrical energy, that the equipment within the installation powered by it works properly and safely.

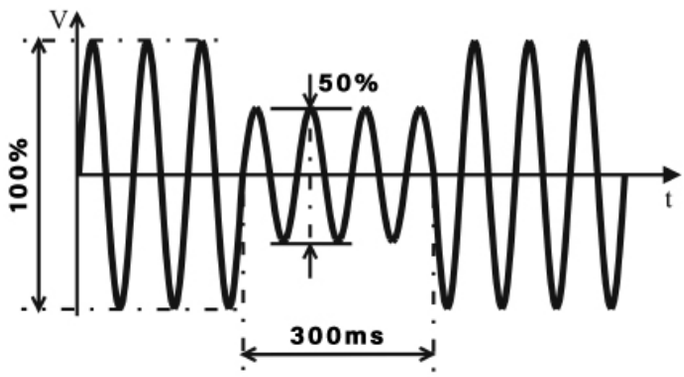
If electrical equipment is to operate correctly, it requires electrical energy to be supplied at a voltage (and frequency) that is within a specified range, and to that end European standard EN50160 "Voltage characteristics of electricity supplied by public distribution systems" was drawn up by CENELEC in November 1994. This standard gives the main characteristics of the voltage at a customers supply terminals in public low voltage and medium voltage electricity distribution systems under normal operating conditions.

The standard gives the limits or values within which the voltage characteristics can be expected to remain, but does not describe the typical situation in a public supply network. It is also the case that the limits are quite wide, 230V ± 10% for example, and it is acceptable for the voltage to drift outside ±10% for 5% of the time. Add to that the further complication that the UK electricity supply is actually specified as 230V +10% -6%.

The bottom line, as with all issues of power quality, is however, not whether the supply voltage meets or does not meet a standard, but the compatibility between the electricity supply and the loads that are connected to it. In other words, that an installation works safely, faultlessly and without interruption, to the requirements and satisfaction of the customer.

What are voltage dips and swells?

A voltage dip, or sag as it is also called, is a sudden reduction in the supply voltage of between 10% and 90%, recovering after a short period of time. Conventionally the duration of a voltage dip is between 10ms and 1 minute. The depth of a voltage dip is defined as the difference between the minimum rms voltage during the dip and the declared voltage. Voltage changes which do not reduce the supply voltage by less than 10% are not considered to be dips.



50% sag / dip lasting for 300ms

Voltage dips may be caused by external or internal factors and can exist as random singular events or a series of repeated occurrences, perhaps with some kind of pattern to their timing. Monitoring and measuring the supply voltage over time will quickly identify what particular events are occurring in an installation and enable location of the causes.

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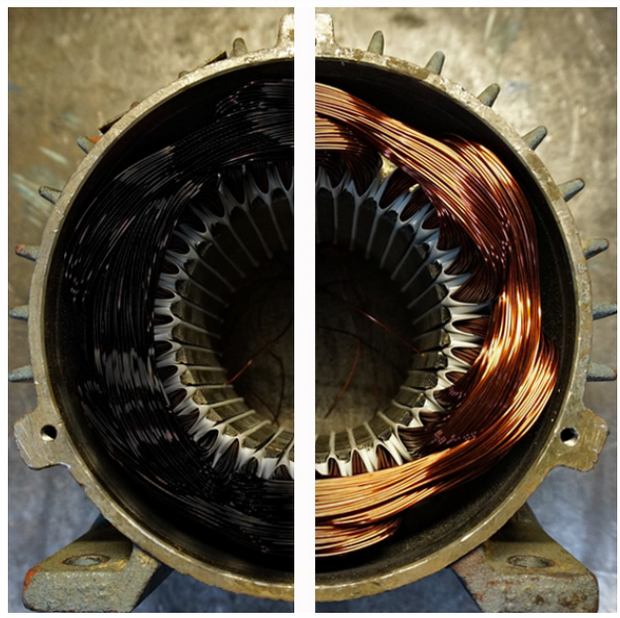
External factors, which are more likely to produce singular events, include short-term reductions in supply voltage caused by load switching and fault clearance in the supply network. A similar effect can occur when switching between the mains supply and uninterruptible power supplies or emergency back-up generators. Common causes of voltage dips within an installation include the switching on and off of large loads including electric motors, arc furnaces and welding equipment, or possibly even loads with pulsating current demands. These may appear as more regular occurrences and at particular times.

The effect that a dip has on the other equipment and the occupants within an installation varies widely, and is dependent on a variety of factors including both the nature of the event itself and the equipment within the installation. It is perfectly possible, for example, for an office environment with equipment powered by switched mode power supplies and UPS systems, fitted out with fluorescent lighting, to experience dips and never even know. However, the same office fitted with different lighting could experience regular and irritating flicker. Flicker is the effect of random and repetitive variations in voltage resulting in rapid visible changes in brightening and dimming of lighting equipment.

A dipping supply voltage can cause particular problems for AC induction motors and with varying severity. As the supply voltage to the induction motor decreases, the motor speed decreases, and depending on the size and the duration of the voltage dip, the motor speed may recover to its normal value as the voltage amplitude recovers. If the voltage dip magnitude and/or duration exceed certain limits the motor may stall, an undervoltage trip may operate or a contactor drop out, or variable speed drives may shut down to prevent potential motor damage.

Voltage swells are simply the opposite to dips and defined as a sudden increase in the supply voltage of 10% or greater followed by a voltage recovery after a short period of time. Again, generally, between 10ms and 1 minute. Swells are almost exclusively caused when a heavy load is turned off somewhere on the power supply network or in the installation itself.



LH winding heat damage due to repeated voltage swells

Although the effects of dips may be more noticeable, the effects of a voltage swell are often more destructive. Regular and sustained voltage swells can lead to early insulation failure in induction motors resulting from increases in current flow and associated overheating.

Swells can cause breakdown of components in equipment power supplies over time due to accumulative overload effects. They can also cause damage to electronic components and other sensitive equipment.

As with all power quality issues there are solutions to the problems, and ways to mitigate the effects, of dips and swells once the causes have been identified and located.

This can be achieved through conducting a site survey, a process of moving around the electrical installation, measuring supply voltage and current consumption over time, and tracking down the sources of dips and swells.

Performing a site survey today is made all the easier with the array of power and energy loggers and power quality analysers available. These products can be connected completely non-intrusiely to various points on the electrical network within the installation, in many cases while the power is maintained, and left to gather information.

If monitoring determines that the problems are coming from the external supply, and the limits of the standard are being exceeded, then it's time to call the electricity supplier.

However, as in many cases, the power quality issue may well be found to be from within the installation itself. If that is the case, then following identification of the circuit supplying the equipment causing the dip, thoughts on mitigating the issue can commence.

These may include supplying the equipment in question from a dedicated circuit so that there are no other items on the same circuit to be affected. This assumes the issue is not so big that it is causing the whole supply to dip, in which case it's time to reduce the load or call the supplier again. Sensitive loads can also be arranged to be fed by separate circuits or connected to regulated/UPS supplies to eradicate any issues.