Types of power system transients

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A transient can be a unidirectional impulse of either polarity or a damped oscillatory wave with first peak occurring in either polarity.

The term transients has been used in the analysis of power system variations to denote an event that is undesirable and momentary in nature. The notion of a damped oscillatory transient due to an RLC network is probably what most power engineers think of when they hear the word transient.

Other definitions in common use are broad in scope and simply state that a transient is “that part of the change in a variable that disappears during transition from one steady state operating condition to another.” Unfortunately, this definition could be used to describe just about anything unusual that happens on the power system. Another word in common usage that is often considered synonymous with transient is surge.

A utility engineer may think of a surge as the transient resulting from a lightning stroke for which a surge arrester is used for protection. End users frequently use the word indiscriminately to describe anything unusual that might be observed on the power supply ranging from sags to swells to interruptions.

Transients can be classified into two categories, impulsive and oscillatory. These terms reflect the wave-shape of a current or voltage transient:

An impulsive transient is a sudden, non-power frequency change in the steady state condition of voltage, current, or both that is unidirectional in polarity (primarily either positive or negative). Impulsive transients are normally characterized by their rise and decay times, which can also be revealed by their spectral content.

Figure 1.2 shows a typical current impulsive transient caused by lightning. Because of the high frequencies involved, the shape of impulsive transients can be changed quickly by circuit components and may have significantly different characteristics when viewed from different parts of the power system. They are generally not conducted far from the source of where they enter the power system, although they may, in some cases, be conducted for quite some distance along utility lines.

Impulsive transients can excite the natural frequency of power system circuits and produce oscillatory transients.

ii. Oscillatory Transient:

An oscillatory transient is a sudden, non-power frequency change in the steady- state condition of voltage, current, or both, that includes both positive and negative polarity values.

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An oscillatory transient consists of a voltage or current whose instantaneous value changes polarity rapidly. It is described by its spectral content (predominate frequency), duration, and magnitude. Oscillatory transients with a primary frequency component greater than 500 kHz and a typical duration measured in microseconds (or several cycles of the principal frequency) are considered high-frequency transients.

These transients are often the result of a local system response to an impulsive transient. A transient with a primary frequency component between 5 and 500 kHz with duration measured in the tens of microseconds (or several cycles of the principal frequency) is termed a medium-frequency transient.