Power Quality RMS Voltage Events

This article briefly describes the detection algorithms of four different RMS voltage events listed in the IEC61000-4-30 [1] standard, suitable for a Class A Power Quality analyser (PQA).

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The four different power quality parameters in relation to RMS voltage events mentioned in the IEC61000-4-30 are:

- Voltage Dips (sag)
- Voltage Swells
- Voltage interruption
- Rapid Voltage Change (RVC)

VOLTAGE DIPS AND SWELLS

A Voltage Dip or Swell is a temporary reduction or increase of the voltage magnitude at a point in the electrical system below or above a threshold [1]; with the Dip or Swell event ending when the RMS is above or below the threshold plus or minus the hysteresis voltage. The threshold and hysteresis values are based on the declared input voltage (U_{din}) and where U_{din} is normally set to the nominal RMS voltage. Hysteresis is used to prevent nuisance triggering. The detection of a Voltage Dip is shown in Figure 1.

An alternative approach for detecting Voltage Dips and Swells is based on the Sliding Reference (U_{SR}) [1]. This is a non-fixed value that is based on the 10/12 cycle (10 for 50Hz or 12 for 60Hz power system) RMS voltage measurements after being passed through a low pass filter with a 1-minute time constant. In this case, the threshold levels are a percentage of U_{SR}. The Sliding Reference method may be suitable where the system voltage varies, for example as a result of dynamic load changes.

VOLTAGE INTERRUPTIONS

"A Voltage Interruption begins when the RMS voltages of all channels fall below the voltage interruption threshold, and ends when the RMS voltage on any one channel is equal to, or greater than, the voltage interruption threshold plus the hysteresis" [1]. The detection of a Voltage Interruption is shown in Figure 2.

RAPID VOLTAGE CHANGE (RVC)

An RVC is defined as a "quick transition in RMS voltage occurring between two steady-state conditions, and during which the RMS voltage does not exceed the dip/swell thresholds" [1]. The detection of a RVC is shown in Figure 3. The RVC event detection requires 100/120 samples of $U_{RMS(1/2)}$ (value of the RMS voltage measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half-cycle) for 50 Hz/60Hz systems [1] (blue trace in Figure 3).

The Arithmetic Mean Voltage (AMV), orange trace in Figure 3, is the average of the most recent 100/120 $U_{RMS(1/2)}$ values. The AMV is updated with every new $U_{RMS(1/2)}$ value. In short, the orange trace is the average of the blue trace in Figure 3. The RVC limits of the AMV are determined by the threshold and hysteresis levels, based on U_{din}. Outside an RVC event, the limits (upper and lower

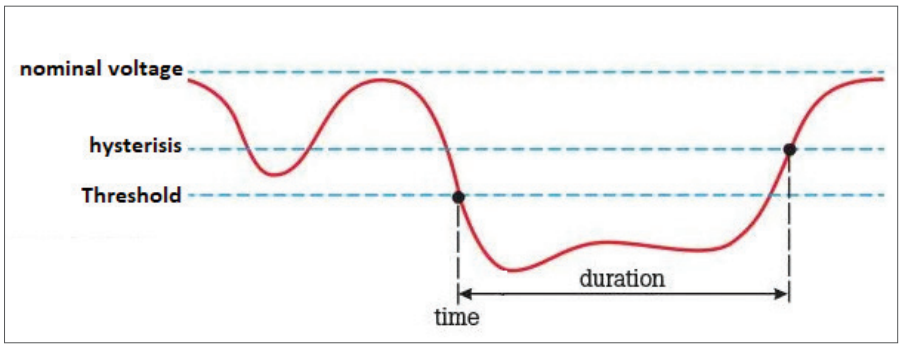

Figure 1 *Visual representation for detection of a Voltage Dip*

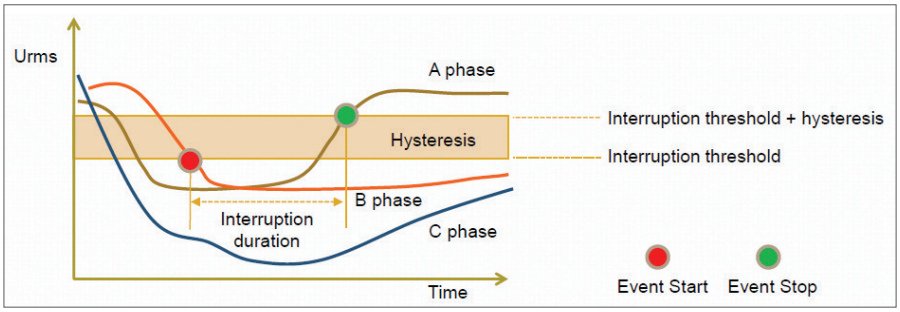

Figure 2 *Visual representation for detection of a Voltage Interruption for a three-phase system*

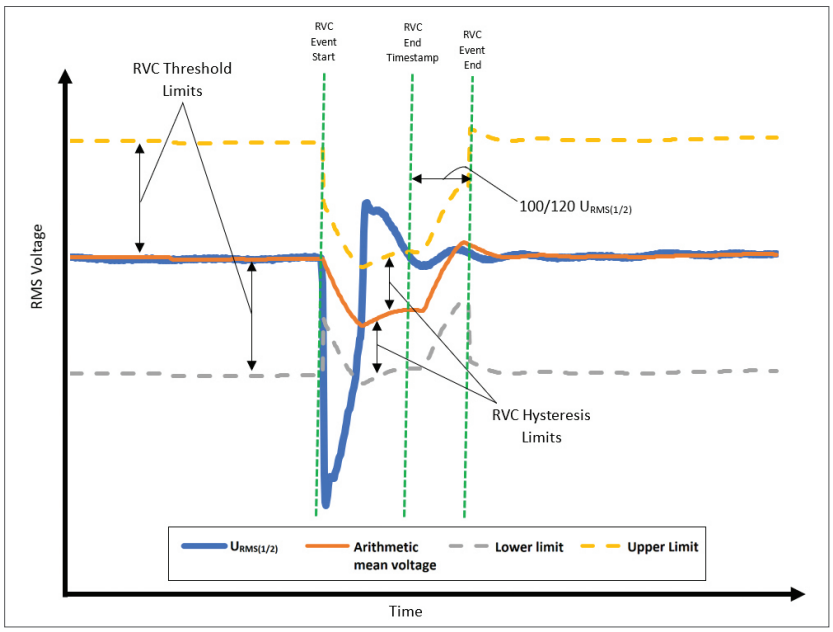

Figure 3 *Visual representation for detection of an RVC event*

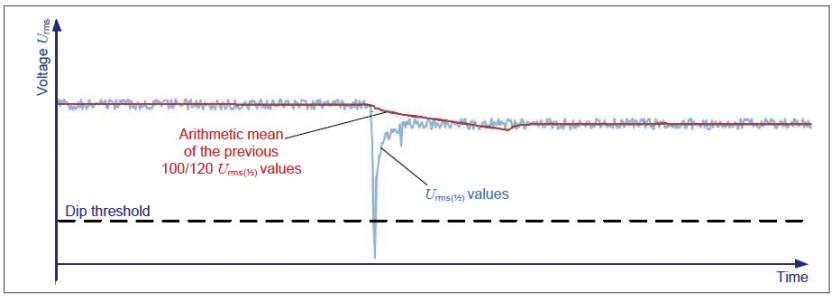

Figure 4 *Not considered an RVC event as the* $U_{RMS(1/2)}$ *value exceeds the voltage dip threshold*

dashed lines) are based on the threshold level only (RVC threshold limits); within an RVC event the limits are based on the hysteresis level only (RVC hysteresis limits). An RMS voltage steady-state condition is when all recent 100/120 $U_{RMS(1/2)}$ values remain within the RVC threshold limits.

An RVC event begins when a single $U_{RMS(1/2)}$ value exceeds the RVC threshold limits; and ends when $U_{RMS(1/2)}$ is back to steady state i.e., $U_{RMS(1/2)}$ is within the RVC hysteresis limits for a time length of at least 100/120 half cycles. It should be noted that the RVC event end time stamp that is reported will be when the $U_{RMS(1/2)}$ is first within the hysteresis limits i.e., 100/120 half cycles earlier than the RVC event end. This implies a minimum RVC event duration of at least 100/120 half cycles. Figure 3 shows that the limits are always equidistant from the AMV.

Lastly, at any point during the RVC event $U_{RMS(1/2)}$ exceeds the dip or swell thresholds, the event is no longer an RVC event and is considered a voltage dip or swell event respectively as seen in example Figure 4 [1]. T&D

References:
[1] International Electrotechnical Comission , IEC61000-4-30-2015: Electromagnetic compatibility (EMC) - Part 4-30: Testing and measurement techniques - Power quality measurement methods, 2015.

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