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Replacing GB/T 30137-2013

Power quality - Voltage swell, voltage dips and short interruptions

电能质量 电压暂升、电压暂降与短时中断

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Foreword

This document was drafted in accordance with the rules given in GB/T 1.1-2020, *Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents*.

This document replaces GB/T 30137-2013 *Power quality - Voltage dips and short interruptions*. Compared with GB/T 30137-2013, in addition to structural adjustments and editorial changes, the main technical changes are as follows:

a) Add "voltage swell" and corresponding contents (see Chapter 1, 3.1, 3.2, 3.5, 3.6, 3.7, 3.8, 3.13, 3.15, Chapter 4, Chapter 5, Chapter 6, Chapter 7);

b) Change the expression of duration in the definition of the term "voltage dip (sag)" (see 3.3; 3.1 of the 2013 edition);

c) Change the expression of duration in the definition of the term "short interruption" (see 3.4; 3.2 of the 2013 edition);

d) Change the name and definition of the term "voltage dip (short interruption) threshold" (see 3.5; 3.3 of the 2013 edition);

e) Change the name and definition of the term "duration of a voltage dip (swell, short interruption)" (see 3.6; 3.4 of the 2013 edition);

f) Change the name and definition of the term "voltage phase-angle jumps" (see 3.7; 3.5 of the 2013 edition);

g) Change the name and definition of the term "voltage dip (short interruption) frequency" (see 3.8; 3.6 of the 2013 edition);

h) Change the name and definition of the term "RMS voltage refreshed each half-cycle" (see 3.9; 3.7 of the 2013 edition);

i) Change the name and definition of the term "residual voltage" (see 3.11; 3.9 of the 2013 edition);

j) Change the definition of the term "depth of voltage dip" (see 3.12; 3.10 of the 2013 edition);

k) Add the term "point-on-wave of voltage dip initiation" and its definition (see 3.17);

l) Add the term "critical distance" and its definition (see 3.18);

m) Add the term "dip area" and its definition (see 3.19);

n) Add "Statistics of voltage swell events" (see Table 1);

Power quality - Voltage swell, voltage dips and short interruptions

1 Scope

This document specifies the indexes and statistical, test, monitoring and assessment methods for voltage swell, voltage dip and short interruption in the electric power system.

This document is applicable to 50 Hz AC power systems.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 19862, General requirements for monitoring equipments of power quality

GB/T 17626.30, Electromagnetic compatibility - Testing and measurement techniques - Part 30: Power quality measurement methods

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

voltage swell

A phenomenon that the r.m.s. voltage at a certain point in the power system suddenly rises to 1.1 p.u. ~ 1.8 p.u. and returns to normal after a short period of 10 ms ~ 1 min.

3.2

magnitude of voltage swell

The maximum value of the r.m.s. voltage during a voltage swell.

3.3

voltage dip; voltage sag

3.15

sliding reference voltage

U_{sr}

The average voltage magnitude within a specific time period, which is used to indicate the voltage before a voltage change event (such as voltage dip, voltage swell, and rapid voltage change).

[Source: GB/T 17626.30-2023, 3.29, modified]

3.16

hysteresis voltage

The difference between the start voltage threshold and the end voltage threshold.

Note 1: The definition of hysteresis in this document is related to power quality measurement parameters. This definition is different from the definition in IEC 60050, which is related to the core saturation.

Note 2: The purpose of introducing the hysteresis term in power quality measurement is to avoid multiple counting of events when the magnitude of the parameter oscillates around the threshold range.

3.17

point-on-wave of voltage dip initiation

The phase of the voltage when the voltage dip occurs.

[Source: GB/T 39269-2020, 3.8, modified]

3.18

critical distance

The distance, when a fault occurs in the power system and the voltage of a node drops to the specified voltage dip threshold, between the fault point and the node.

3.19

dip area; sag area

The area in the power system that consists of all fault points which cause the voltage of a node to drop to the specified voltage dip threshold.

Where:

X – the percentage of the r.m.s. voltage to the nominal voltage, X% is the r.m.s. voltage threshold. X can be 180, 170, 160, 150, 140, 130, 120, 110, 90, 80, 70, 60, 50, 40, 30, 20, 10, etc.;

N_i – When X < 100, N_i is the number of users who suffer voltage dip or short interruption with voltage magnitude less than X% in the i^{th} event; when X >100, N_i is the number of users who suffer voltage swell with voltage magnitude greater than X% in the i^{th} event;

N_{Total} – the total number of users whose power is supplied by the evaluated measuring point.

$$SARFI_{X\text{-}T} = \frac{N \times D}{D_{Total}} \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

Where:

X – the percentage of the r.m.s. voltage to the nominal voltage. X% is the r.m.s. voltage threshold. X can be 180, 170, 160, 150, 140, 130, 120, 110, 90, 80, 70, 60, 50, 40, 30, 20, 10, etc.

N – When X <100, N is the number of voltage dips or short interruptions with voltage magnitude less than X% during the monitoring period; when X >100, N is the number of voltage swells with voltage magnitude greater than X% during the monitoring period;

D_{Total} – the total number of days in the monitoring period;

D – index calculation cycle days, which can be 30 or 365. The corresponding indexes represent the average number of events in which the residual voltage is less than X% or the magnitude of voltage swell is greater than X% per month or year, respectively, where $D \leq D_{Total}$.

b) SARFI-CURVE

SARFI-CURVE index is a statistical probability that a voltage swell, voltage dip or short interruption exceeds the area defined by the tolerance curve of a certain type of sensitive equipment. Different tolerance curves correspond to different SARFI-CURVE indexes. For descriptions of different voltage tolerance curves, see Appendix A.

4.2.2 Frequency index

The frequency index reflects the frequency of voltage swells, voltage dips or short interruptions. Frequency statistics and evaluation can be carried out through monitoring or other means, and the general statistical cycle is 1 year. The event frequency of a node or the total event frequency of a regional power grid can be counted.

5.2.1 Threshold setting

The threshold for voltage swell is generally set at 1.1 p.u.; the threshold for voltage dip is generally set at 0.9 p.u.; the threshold for short interruption is generally set at 0.1 p.u.

5.2.2 Determination of voltage swell

In a single-phase system, when $U_{rms(1/2)}$ or $U_{rms(1)}$ is higher than the swell threshold, the voltage swell event begins; when $U_{rms(1/2)}$ or $U_{rms(1)}$ is equal to or lower than the difference between the voltage swell threshold and the hysteresis voltage, the voltage swell ends. In a multi-phase system, when $U_{rms(1/2)}$ or $U_{rms(1)}$ of any phase is higher than the swell threshold, the voltage swell begins; when $U_{rms(1/2)}$ or $U_{rms(1)}$ of all phases is equal to or lower than the difference between the swell threshold and the hysteresis voltage, the voltage swell ends.

5.2.3 Determination of voltage dip

In a single-phase system, when $U_{rms(1/2)}$ or $U_{rms(1)}$ is lower than the dip threshold, the voltage dip event begins; when $U_{rms(1/2)}$ or $U_{rms(1)}$ is equal to or higher than the sum of the dip threshold and the hysteresis voltage, the voltage dip ends. In a multi-phase system, when $U_{rms(1/2)}$ or $U_{rms(1)}$ of any phase is lower than the dip threshold, the voltage dip begins; when $U_{rms(1/2)}$ or $U_{rms(1)}$ of all phases is equal to or higher than the sum of the dip threshold and the hysteresis voltage, the voltage dip ends.

5.2.4 Determination of short interruption

In a single-phase system, when $U_{rms(1/2)}$ or $U_{rms(1)}$ is lower than the short interruption threshold, the short interruption event begins; when $U_{rms(1/2)}$ or $U_{rms(1)}$ is equal to or higher than the sum of the short interruption threshold and the hysteresis voltage, the short interruption ends. In a multi-phase system, when $U_{rms(1/2)}$ or $U_{rms(1)}$ of any phase is lower than the short interruption threshold, the short interruption begins; when $U_{rms(1/2)}$ or $U_{rms(1)}$ of all phases is equal to or higher than the sum of the short interruption threshold and the hysteresis voltage, the short interruption ends.

5.3 Method for selecting values of characteristic parameters

5.3.1 Voltage swell

The characteristic parameters of voltage swell include magnitude of voltage swell (U_{max}), duration, and phase-angle jump. The magnitude of voltage swell (U_{max}) is the maximum value of U_{rms} measured on any channel during the voltage swell process. The start time of voltage swell shall be the end time of U_{rms} measurement data window triggering the event channel, and the end time of voltage swell shall be the end time of U_{rms} measurement data window terminating the event channel. U_{rms} is determined by the difference between the threshold and the hysteresis voltage. The duration of a voltage swell is the time difference from the start to the end of the voltage swell.

Note 1: For multi-phase system measurements, the voltage swell duration measurement may start on one channel and end on another channel.

Note 2: The envelope curve of voltage swell is not necessarily rectangular. For a given voltage swell, the duration of the measurement depends on the swell threshold.

Note 3: The hysteresis voltage is typically 2% of U_{din}.

Note 4: The swell threshold is typically greater than or equal to 110% of U_{din}.

Note 5: Phase-angle jumps may also occur during voltage swells. For the phase-angle jump detection algorithm, refer to Appendix B.

Note 6: When exceeding the threshold, record a time stamp.

5.3.2 Voltage dip

The characteristic parameters of voltage dip include residual voltage (U_{res}) or depth, duration, and phase-angle jump; the residual voltage is the lowest U_{rms} value measured on any channel during the dip. The start time of the voltage dip shall be the end time of the U_{rms} measurement data window triggering the event channel; the end time of the voltage dip shall be the end time of the U_{rms} measurement data window terminating the event channel. U_{rms} is determined by the sum of the threshold and the hysteresis voltage. The duration of a voltage dip is the time difference from the start to the end of the voltage dip.

Note 1: For multi-phase system measurements, the voltage dip duration measurement may start on one channel and end on another channel.

Note 2: The envelope curve of the voltage dip is not necessarily rectangular. For a given voltage dip, the duration of the measurement depends on the dip threshold. Generally, use multiple dip thresholds (set within the voltage dip and voltage interruption threshold range) to estimate the envelope curve of the voltage dip.

Note 3: The hysteresis voltage is typically 2% of U_{din}.

Note 4: In applications such as fault troubleshooting or statistical analysis, the dip threshold is usually 85% ~ 90% of the fixed reference voltage.

Note 5: The residual voltage is usually useful to the end user and may be used preferentially because it is referenced to zero potential. In contrast, depth is often useful on the electrical supply side, especially for high voltage systems or when a sliding reference voltage is used.

Note 6: Phase-angle jumps may also occur during voltage dips. For the phase-angle jump detection algorithm, refer to Appendix B.

Grade A performance – meeting the Grade A measurement method and uncertainty requirements in GB/T 17626.30, capable of accurately measuring the magnitude, duration, phase-angle jump and other characteristic parameters of voltage swell, voltage dip and short interruption. Each measurement channel can measure the r.m.s. voltage refreshed each half-cycle [$U_{rms(1/2)}$]. This grade of instrument is suitable for occasions where precise measurements are required, such as standard compliance inspection, dispute resolution, power quality contract arbitration, etc.

Grade S performance – meeting the Grade S measurement method and uncertainty requirements in GB/T 17626.30, and capable of measuring characteristic parameters such as the magnitude and duration of voltage swells, voltage dips and short interruptions. Each measurement channel can measure the r.m.s. voltage refreshed each half-cycle [$U_{rms(1/2)}$] or the r.m.s. voltage refreshed each cycle [$U_{rms(1)}$]. This grade of instrument is suitable for power quality survey statistics, troubleshooting and other applications that do not require high accuracy.

An appropriate instrument performance grade shall be selected according to the specific application.

6.2 Technical requirements for monitoring instruments

6.2.1 Basic functions

6.2.1.1 Monitoring function

The instrument shall be able to perform real-time monitoring of voltage swell, voltage dip or short interruption events through voltage measurement, and obtain characteristic parameters such as magnitude of voltage swell, residual voltage, and duration.

6.2.1.2 Waveform recording function

The event waveform record of the instrument shall be able to restore the process of voltage instantaneous waveform changes within the recording time period, and shall include waveforms of at least 5 cycles before the event and at least 20 cycles after the event. Instruments of Grade A performance have the function of recording event waveforms with a recording length of not less than 1 s, and instruments of Grade S performance have the function of recording event waveforms with a recording length of not less than 0.5 s.

6.2.1.3 Other functions

The display, communication interface, authority management, parameter configuration, timing, storage and statistical functions of the instrument shall meet the requirements of GB/T 19862 and have the function of threshold setting.

6.2.2 Instrument accuracy

The voltage magnitude measurement error of instruments of Grade A performance shall not exceed ±0.2% of the declared input voltage; the voltage magnitude measurement error of instruments of Grade A shall not exceed ±1.0% of the declared input voltage.

The duration measurement error of instruments of Grade A performance shall not exceed ±1 cycle; the duration measurement error of instruments of Grade S performance shall not exceed ±2 cycles.

The phase-angle jump measurement error of instruments of Grade A performance shall not exceed ±1°.

6.2.3 Electrical performance requirements, normal use conditions, enclosure, mechanical performance, safety performance, and electromagnetic compatibility (EMC)

The instruments shall meet the requirements of GB/T 19862.

6.3 Monitoring requirements

Select monitoring points as needed and install online monitoring devices to continuously monitor voltage swells, voltage dips and short interruptions.

The monitoring records shall include characteristic parameters of each phase event, time of occurrence, monitoring points, etc., and event statistics shall be carried out in accordance with the requirements of Tables 1 and 2 in 4.1.

7 Assessment of voltage swells, voltage dips and short interruptions

7.1 General

The assessment of voltage swell, voltage dip and short interruption is divided into single measuring point index and system index assessment. Determine the assessment object and scope based on the source and purpose of the assessment task; analyze the index results; form an assessment report. If necessary, corresponding improvement measures shall be suggested.

7.2 Single-measuring point index assessment

The single-measuring point indexes are used to characterize the overall characteristics of voltage swells, voltage dips or short interruptions that occur at a specific node within a certain period of time (typically one year), including SARFI index, severity index, frequency index and energy index, and are assessed according to the calculation method of the recommended indexes in 4.2. Single-measuring point indexes can be used to assess the compatibility between sensitive equipment and power supply, can also help select the installation site for sensitive loads, and can provide local users with the

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