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# GB/T 29319-2024

Replacing GB/T 29319-2012

## Technical requirements for connecting photovoltaic power system to distribution network

光伏发电系统接入配电网技术规定

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## 1 Scope

The document lays down the technical requirements for active power, reactive power and voltage, fault ride-through, operational adaptability, power quality, starting and stopping, relay protection, power forecasting, electrical energy metering, communication and information, and simulation model and parameters where a photovoltaic power system is connected to a distribution network, together with the content of grid connection testing and evaluation.

It applies to the connection, commissioning and operation of new, rebuilt and extended photovoltaic power systems connected three-phase at a voltage level of 10 kV and below. Photovoltaic power systems fitted with energy storage may follow it for reference.

## 2 Normative references

The national standards cited are GB/T 12325 on supply voltage deviation, GB/T 12326 on voltage fluctuation and flicker, GB/T 13955 on the installation and operation of residual current operated protective devices, GB/T 14285 on relay protection and automatic safety devices, GB/T 14549 on harmonics in public supply networks, GB/T 15543 on three-phase voltage unbalance, GB/T 15945 on power system frequency deviation, GB/T 17215.321 on static meters for active energy of classes A, B, C, D and E, GB/T 19862 on general requirements for power quality monitoring equipment, GB/T 24337 on interharmonics in public supply networks, GB/T 32826 on modelling of photovoltaic power systems, GB/T 32892 on models and parameter testing of photovoltaic power systems, GB/T 33982 on relay protection for distributed resources connected to the grid, and GB/T 40595 on primary frequency regulation of grid-connected power sources.

The power industry standards cited are DL/T 448 on the technical management of electrical energy metering devices, DL/T 614 on multi-function watt-hour meters, DL/T 634.5101 and DL/T 634.5104 on telecontrol equipment and systems transmission protocols, DL/T 645 on the communication protocol of multi-function watt-hour meters, and DL/T 698.45 on the object-oriented data exchange protocol of electrical energy information acquisition and management systems.



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## 3 Terms and definitions

The terms and definitions given in GB/T 12325 and GB/T 40595 apply, together with the following.

3.1 photovoltaic (PV) power generation system: a power generation system that converts solar radiant energy into electrical energy through the photovoltaic effect of solar cells.

3.2 point of common coupling: the point at which the photovoltaic power system connects to the public supply network.

3.3 point of connection: for a photovoltaic power system with a step-up station, the high voltage side busbar or node of that station; for one without, the output collecting point of the photovoltaic power system. A note refers to Annex A for illustrations of the point of connection and the point of common coupling.

3.4 response time: in a control process, the time from receipt of a control instruction or detection of the change in the state quantity that triggers the control action until the actual output of the observed variable first reaches 90 % of the difference between the control target value and the initial value. The source is given as GB/T 40289-2021, 3.13.

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## 4 Active power

4.1 Active power control. A photovoltaic power system connected at the 10(6) kV voltage level shall be able to receive and execute active power control instructions automatically, with a control error whose absolute value is not greater than 1 % of the rated active power and a response time not greater than 5 s. A photovoltaic power system connected at the 380 V voltage level shall be able to receive and execute active power control instructions automatically.

4.2 Primary frequency regulation. A photovoltaic power system connected at the 10(6) kV voltage level shall have primary frequency regulation capability. Where the power system frequency deviation goes outside the primary frequency regulation dead band, the change in active power is calculated by formula (1), whose legend gives delta Pt as the change in active power of the photovoltaic power system in megawatts (MW), kf as the active frequency regulation coefficient, ft as the power system frequency in hertz (Hz), fN as the rated power system frequency in hertz (Hz), and PN as the rated active power of the photovoltaic power system in megawatts (MW).

The active frequency regulation coefficient and the dead band are fixed by the power system dispatching body according to the frequency regulation characteristics of the power system connected to, the coefficient preferably taking a value from 10 to 50 and the dead band preferably +/- 0.02 Hz to 0.06 Hz. Where the power system frequency is above 50 Hz, the limiting amplitude by which the photovoltaic power system reduces active power should be not less than 10 % of rated active power. Where the power system frequency is below 50



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Hz, a photovoltaic power system fitted with energy storage shall increase active power, the limiting amplitude of the increase being preferably not less than 6 % of rated active power. The lag time of the primary frequency regulation response shall be not greater than 1 s, the response time not greater than 5 s and the settling time not greater than 15 s, and the active power regulation deviation once primary frequency regulation is steady shall not exceed +/- 1 % of rated active power.

## 5 Reactive power and voltage

The reactive output range of the photovoltaic inverter shall be dynamically adjustable within the rectangle shown in Figure 1, whose key gives P as the per unit active power of the photovoltaic inverter and Q as its per unit reactive power. The figure itself is a diagram and its coordinates are not reproduced in the extracted text.

The photovoltaic power system shall have several reactive power control modes, among them reactive voltage control, constant power factor control and constant reactive power control. It shall be able to take part in regulating the voltage at the point of connection, preferably by adjusting its own reactive power and active power. The power factor at the point of connection shall be continuously adjustable within the range 0.95 leading to 0.95 lagging.

## 6 Fault ride-through

6.1 Low voltage ride-through. Where a power system fault causes the voltage at the point of connection to dip, the photovoltaic power system shall have the low voltage ride-through capability of Figure 2: where the voltage dips to zero it shall run on without disconnection for 150 ms; where it dips to 20 % of nominal voltage it shall run on for 625 ms; and where it dips to between 20 % and 85 % of nominal voltage it shall run on within the shaded area of Figure 2. Table 1 gives the assessment voltage for low voltage ride-through under different fault types in three rows: for a three-phase short circuit fault, the line voltage at the point of connection; for a two-phase short circuit fault, the line voltage at the point of connection; and for a single-phase earth short circuit fault, the phase voltage at the point of connection.

A photovoltaic power system connected at the 10(6) kV voltage level shall have dynamic reactive support capability during low voltage ride-through. For a symmetrical fault, where the voltage at the point of connection falls below 85 % of nominal voltage the reactive current injected into the network shall be the sum of the reactive current output I0 in normal operation before the dip and the dynamic reactive current increment delta It, the increment being calculated by formula (2), whose legend gives delta It as the injected dynamic reactive current increment in amperes (A), K1 as the dynamic reactive current proportional coefficient, Ut as the per unit voltage at the point of connection and IN as the rated current of the photovoltaic power system in amperes (A). The coefficient K1 may be fixed according to the actual condition of the power system and should take a value from 1.5 to 3. The rise



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