

Translated English of Chinese Standard: GB/T40427-2021
www.ChineseStandard.net → Buy True-PDF → Auto-delivery.
Sales@ChineseStandard.net

GB

NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA

ICS 29.020

CCS F 21

GB/T 40427-2021

**Technical guidelines for power system voltage and reactive
power**

电力系统电压和无功电力技术导则

Issued on: October 11, 2021

Implemented on: May 01, 2022

**Issued by: State Administration for Market Regulation;
Standardization Administration of the People's Republic of China.**

Table of Contents

Foreword	3
1 Scope	4
2 Normative references	4
3 Terms and definitions	4
4 General requirements	6
5 Allowable voltage deviation	7
6 Reactive power balance and compensation	9
7 Selection of reactive power compensation equipment	12
8 Selection of voltage regulating manner and voltage regulation range of transformers	12
9 Reactive voltage control of power system	14
Bibliography	15

Technical guidelines for power system voltage and reactive power

1 Scope

This document specifies the basic technical requirements for the voltage and reactive power of various voltage levels of the power system, the allowable voltage deviation, the reactive power balance and compensation, the selection of reactive power compensation equipment, the selection of transformer voltage regulating manner and voltage regulation range, and the reactive voltage control of the power system.

This document is applicable to the voltage control and reactive power configuration of the power system of various voltage levels for power generation, transmission, distribution and utilization.

2 Normative references

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

GB/T 19963 Technical specification for connecting wind farm to power system

GB/T 19964 Technical requirements for connecting photovoltaic power station to power system

GB/T 31460 Technical guide for reactive power compensation and allocation of HVDC converter stations

GB 38755 Code on security and stability for power system

GB/T 38969 Guide on technology for power system

NB/T 32015 Technical rule for distributed resources connected to distribution network

3 Terms and definitions

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

3.1

reverse voltage regulating manner

The voltage regulating manner in which the voltage of the central point is reversely regulated with the increase or decrease of the load, that is, the voltage of the central point is increased when the load is large, and the voltage of the central point is decreased when the load is small.

3.8**balance of reactive**

Under a certain system voltage level, the state in which the reactive output is balanced with the reactive load of the reactive power source in the power system.

3.9**automatic voltage control; AVC**

Using computer system, communication network and controllable equipment, calculate the control strategy online according to the real-time operating conditions of the power grid, and automatically closed-loop control the reactive power and voltage regulation equipment, to achieve a reasonable reactive voltage distribution.

4 General requirements

4.1 The voltage of each voltage level node in the power system shall meet the requirements of allowable voltage deviation.

4.2 The reactive power compensation of the power grid shall meet the principle of hierarchical and on-site balancing under the highest and lowest load levels, shall be adjusted with the load (or voltage) changes, and shall avoid the transmission of reactive power through long-distance lines or multi-level transformers.

4.3 In the planning and design of the power system, it shall carry out the planning of reactive power compensation equipment/reactive power source, and reserve an appropriate margin.

- a) In the planning and design of power generation, transmission, distribution and utilization projects, it shall carry out special research on reactive voltage; if necessary, it shall carry out calculation and analysis of overvoltage, including power frequency overvoltage, operating overvoltage, resonance overvoltage, submerged supply current and recovery voltage, etc.
- b) In the planning and design of the receiving end system, it shall strengthen the network connection of the highest-level voltage; it shall be connected to a power source with sufficient capacity and support and adjustment capabilities to ensure

the flexibility of the voltage support and operation of the receiving end system; it shall configure sufficient reactive power compensation capacity.

- c) For DC drop points, load concentration areas and channels such as new energy centralized transmission, it shall reasonably configure dynamic var compensation equipment.
- d) For the configuration of reactive power compensation equipment and the selection of equipment type, it shall be compared technically and economically. For power grids of 220 kV and above, it should consider the need to improve the stability of the power system.

4.4 There shall be sufficient reactive power reserve for the operation of the power system to ensure the normal operation of the power system and the voltage stability after accident.

4.5 The synchronous generator or synchronous phase conditioner shall operate with automatic regulation excitation (including forced excitation), with sufficient phase advance and retardation capability, and maintain the stability of its operation.

4.6 The new energy station shall have reactive power regulation capability and automatic voltage control function, and maintain the stability of its operation. In principle, the reactive power regulation capability of the new energy station shall be consistent with that of the synchronous generator set.

4.7 The distribution network below 110 kV shall adopt a reasonable power supply radius.

4.8 According to the structure of the power grid and the nature of the load, it shall reasonably select the voltage regulation range and voltage regulating manner of the tap changer of the step-up and step-down transformer in the voltage network of all levels.

5 Allowable voltage deviation

5.1 Allowable voltage deviation at user's receiving end

5.1.1 The sum of the absolute value of the positive and negative deviations of the user power supply voltage of 35 kV and above shall not exceed 10 % of the nominal voltage.

5.1.2 The allowable deviation of the three-phase power supply voltage of 20 kV and below shall be $\pm 7\%$ of the nominal voltage.

5.1.3 The allowable deviation of 220 V single-phase power supply voltage shall be $-10\% \sim +7\%$ of the nominal voltage.

5.1.4 The allowable voltage deviation of special users shall be determined according to the value agreed upon in the electricity supply contract.

5.2.7 A 10 kV (or 20 kV or 6 kV) busbar shall make the voltage of all the high-voltage users of the line and the low-voltage users powered by the distribution transformer meet the requirements of 5.1.

5.2.8 The allowable deviation of the voltage at the grid connection point of wind farms and photovoltaic power stations: when the voltage of the public grid is within the normal range, for the wind farm that is connected to the public grid with a voltage level of 220 kV (or 330 kV) and below, the wind farm shall be able to control the voltage at the grid connection point within the range of $-3\% \sim +7\%$ of the nominal voltage. For the wind farm in the wind farm group that is connected to the public grid through a voltage level of 220 kV (or 330 kV) that is boosted to a voltage level of 500 kV (or 750 kV) through the wind power collection system, the wind farm shall be able to control the voltage at the grid connection point within the range of $0\% \sim 10\%$ of the nominal voltage. For the photovoltaic power station that is connected to the power grid through a voltage level of 110 kV (66 kV), it shall be able to control the voltage at the grid connection point within the range of $-3\% \sim +7\%$ of the nominal voltage. For the photovoltaic power station that is connected to the power grid through a voltage level of 220 kV and above, it shall be able to control the voltage at the grid connection point within the range of $0\% \sim +10\%$ of the nominal voltage. They shall meet the requirements of GB/T 19963 and GB/T 19964. For the distributed power source that is connected to the distribution network, the voltage deviation of the grid connection point shall meet the requirements of 5.1.

6 Reactive power balance and compensation

6.1 The reactive power compensation of power grids is mainly to compensate the reactive power demand of the public network and the system. The reactive power compensation of the power user is mainly to compensate the reactive power demand of the load side.

6.2 For 220 kV/330 kV/500 kV/750 kV/1000 kV power grids, it shall configure high- and low-voltage parallel reactors according to the basic requirement of hierarchical and on-site balancing, to compensate the charging power of the transmission line. The charging power of overhead lines of 330 kV and above and cable lines of 220 kV and above shall be basically compensated. The capacity distribution of high- and low-voltage parallel reactors shall be comprehensively researched and decided according to the system conditions and their respective characteristics.

6.3 In the planning and design stage, the configuration of capacitive reactive power compensation equipment should adopt the method of power flow analysis, to achieve the goal of hierarchical and on-site balancing of reactive power under the highest load level, to ensure that the busbar voltage of each voltage level is within a reasonable range. It shall reserve a reasonable maintenance reserve and accident reserve.

6.4 The reactive power compensation of 6 kV ~ 20 kV distribution network is mainly based on the low-voltage side compensation of the distribution transformer, supplemented by the high-voltage side compensation. The reactive power compensation capacity of the distribution transformer can be configured according to 20 % ~ 40 % of the transformer capacity. High-voltage capacitors can be appropriately installed on overhead lines with long power supply distance and low power factor, and their capacity can be determined by calculation, or configured so that it is not more than 10 % of the total capacity of distribution transformers on the line, but shall not send reactive power back to the system when the load is low. If the configuration capacity is too large, an automatic switching device shall be installed.

6.5 The power factor of power users shall meet the following requirements:

- a) For power users with a high-voltage power supply of 35 kV and above, after considering reactive power compensation, the power factor of the primary side of the transformer shall not be lower than 0.95 when the load is peak, and the power factor shall not be higher than 0.95 when the load is low.
- b) For power users with a power supply of 100 kVA and above 10 kV, the power factor shall be above 0.95.
- c) Electricity users shall not send reactive power to the system, and shall not absorb a large amount of reactive power from the power grid when the power grid load peaks.

6.6 Requirements for generators (including steam turbine generators, hydro generators and pumped storage generators):

- a) Determine the rated power factor (late phase) value of generators according to the following requirements:
 - For the generator that is directly connected to the power grid of 330 kV and above, and is at the sending end, the power factor should be selected as 0.9; for the generator at the receiving end, the power factor can be selected from 0.85 ~ 0.9.
 - For the generator at the sending end of the DC transmission system, the power factor should be selected as 0.85; for the generator of AC-DC mixed transmission system, the power factor can be selected from 0.85 ~ 0.9.
 - The power factor of other generators can be selected according to 0.8 ~ 0.85.
- b) Determine the generator's ability to absorb reactive power (phase advance) according to the following requirements:
 - All newly installed generators shall be capable of running with a power factor advance of 0.95 when the active power is at the rated value.

7 Selection of reactive power compensation equipment

7.1 Parallel capacitors and parallel reactors shall be used as the preferred equipment for reactive power compensation in the power system. The capacity of a single bank should not be too large, and the voltage change rate during switching shall not exceed 2.5 %. When there are many short lines with voltage level of 330 kV and above in local areas, according to the principle of on-site balancing of reactive power and the structural characteristics of the power grid, after calculation and analysis, it shall install busbar high-voltage parallel reactors at appropriate locations for reactive power compensation. The busbar high-voltage parallel reactor shall be equipped with a circuit breaker.

7.2 When power grids of 220 kV and above have problems such as large-capacity DC drop point near areas, lack of dynamic reactive power support in high-proportion power receiving areas and lack of voltage support in the middle of long-distance power transmission lines, in order to improve transmission capacity and system stability, it is necessary to install dynamic var compensation equipment. When the technology and economy are more reasonable, phase conditioners can be selected.

7.3 For power users with shock loads or large load fluctuations and serious imbalance, it shall configure dynamic var compensation equipment such as static var generators.

7.4 For the capacitive reactive power compensation equipment installed in the converter station, AC filters should be the first choice to meet the harmonic performance index and reactive power compensation requirements of the converter busbar. Parallel capacitors are used for the insufficient part. The inductive reactive power compensation equipment installed in the converter station should be switchable high-voltage or low-voltage parallel reactors.

7.5 In areas with a high proportion of new energy grid-connected power generation, the new energy station shall provide necessary short-circuit capacity support for the system by means of configuration such as phase conditioners, and select reactive power compensation equipment with better steady-state and dynamic voltage regulation performance.

8 Selection of voltage regulating manner and voltage regulation range of transformers

8.1 The rated transformation ratio, voltage regulating manner, voltage regulation range and voltage regulation value of each gear of the transformers at all levels shall meet the requirements of power plant, substation busbar and user voltage quality, and consider the needs of power system development.

8.2 The rated voltage of the high-voltage side of the generator's step-up transformer shall be determined through calculation and demonstration according to the

requirements of system voltage control and hierarchical balance of reactive power. The sending end should use 1.05 ~ 1.1 times the nominal system voltage, and the receiving end should be determined according to the operating voltage of the system.

8.3 The rated voltage of the high-voltage side of the step-down transformer shall be determined according to the operating voltage of the system. The rated voltage of the medium-voltage side and the low-voltage side should be 1.0 ~ 1.05 times the nominal system voltage.

8.4 The generator's step-up transformer can be of the non-excitation voltage regulation type. For units whose phase advance capability may be limited due to the plant voltage, it should adopt the on-load voltage regulating manner. The step-up transformer of the new energy station should adopt the on-load voltage regulation type.

8.5 The step-down transformer with a voltage level of 330 kV and above should adopt the non-excitation voltage regulation type. For areas where the voltage fluctuates greatly with the load and the voltage regulation is difficult, it can adopt the on-load voltage regulation type. In other areas, when it is necessary and reasonable in technology and economy after the voltage regulation calculation and demonstration, it can adopt the on-load voltage regulation type.

8.6 The step-down transformer that directly supplies power to the 20 kV or 10 kV distribution network shall be of the on-load voltage regulation type. After the voltage regulation calculation, if only this voltage regulation of one level cannot meet the requirements of voltage control, it can add another one level of on-load voltage regulating transformer to the step-down transformers at all levels on the power supply side.

8.7 When the power user's requirements for voltage quality are higher than the requirements in 5.1, the user's transformer shall adopt the on-load voltage regulation type.

8.8 The voltage regulation range of the transformer's tap changer shall be determined by the voltage regulation calculation. For non-excitation voltage regulating transformers, it can adopt $\pm 2 \times 2.5\%$ (for 1000 kV transformers, it can adopt $\pm 4 \times 1.25\%$). For on-load voltage regulating transformers, with a voltage level of 66 kV and above, it should adopt $\pm 8 \times 1.25\% \sim \pm 8 \times 1.5\%$; with a voltage level of 35 kV, it should adopt $\pm 3 \times 2.5\%$. For the step-up transformers located in the power plant in the load center area, the voltage regulation range of the tap changer on the high-voltage side shall be appropriately reduced by 2.5 % ~ 5.0 %; for the transformers located in the step-down substation near the power plant at the sending end of the system, the voltage regulation range of the high-voltage side shall be appropriately moved up by 2.5 % ~ 5 %.

This is an excerpt of the PDF (Some pages are marked off intentionally)

Full-copy PDF can be purchased from 1 of 2 websites:

1. <https://www.ChineseStandard.us>

- SEARCH the standard ID, such as GB 4943.1-2022.
- Select your country (currency), for example: USA (USD); Germany (Euro).
- Full-copy of PDF (text-editable, true-PDF) can be downloaded in 9 seconds.
- Tax invoice can be downloaded in 9 seconds.
- Receiving emails in 9 seconds (with download links).

2. <https://www.ChineseStandard.net>

- SEARCH the standard ID, such as GB 4943.1-2022.
- Add to cart. Only accept USD (other currencies - <https://www.ChineseStandard.us>).
- Full-copy of PDF (text-editable, true-PDF) can be downloaded in 9 seconds.
- Receiving emails in 9 seconds (with PDFs attached, invoice and download links).

Translated by: Field Test Asia Pte. Ltd. (Incorporated & taxed in Singapore. Tax ID: 201302277C)

About Us (Goodwill, Policies, Fair Trading...): <https://www.chinesestandard.net/AboutUs.aspx>

Contact: Wayne Zheng, Sales@ChineseStandard.net

Linkin: <https://www.linkedin.com/in/waynezhengwenrui/>

----- The End -----