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Replacing GB/T 19826-2005

General specification and safety requirements for DC power supply equipment of power projects

电力工程直流电源设备 通用技术条件及安全要求

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Foreword

This Standard is drafted according to the rules in GB/T 1.1-2009.

This Standard replaces GB/T 19826-2005 “General specification and safety requirements for DC power supply equipment of power project”. Compared with GB/T 19826-2005, the main technical changes in this Standard are as follows:

- ADD the requirements of integrated power supply equipment;
- CHANGE the range of AC input voltage from (85 % ~ 115 %)U_n to (85 % ~ 120 %)U_n;
- CHANGE the ripple coefficient to ripple factor, which is redefined and coordinated with other standards;
- ADD the requirements of soft start characteristic;
- DELETE the requirements of other charging units;
- DELETE the requirements of cadmium-nickel storage battery.

This Standard is proposed by China Electrical Equipment Industry Association.

This Standard is under the jurisdiction of National Technical Committee on Measuring Relay and Protective Equipment of Standardization Administration of China (SAC/TC 154).

Drafting organizations of this Standard: Xuchang Ketop Electric Research Institute, Shenzhen Power Supply Bureau Co., Ltd., Xuji Power Supply Co., Ltd., Emerson Network Power Co., Ltd., Shenzhen Auto Electric Power Plant Co., Ltd., Shenzhen Increase Science and Technology Development Co., Ltd., Guangzhou Toshiba Bai Yunling Machine Power Electronics Co., Ltd., Yantai Dongfang Yulin Electric Co., Ltd., China Titans Energy Technology Group Co., Ltd., Ontech Electric Corporation, Hangzhou Zhongheng Electric Co., Ltd., Integrated Electronic Systems Lab Co., Ltd., Hebei Beiheng Electrical Technology Co., Ltd, Henan Electric Power Test and Research Institute, Zhengzhou Power Supply Company, Southwest Electric Power Design Institute and Henan Electric Power Survey & Design Institute.

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This Standard was firstly issued in 2005, and this is the first revision.

General specification and safety requirements for DC power supply equipment of power projects

1 Scope

This Standard specifies the general specification and safety requirements for DC power supply equipment and integrated power supply equipment of power projects as well as the requirements of such aspects as test methods, inspection rules, marking, packaging, transportation and storage.

This Standard is applicable to the DC and integrated power supply equipment (hereinafter referred to as “product”) of power projects and serves as the criteria for product design, manufacturing, inspection and application. It also serves as the reference for the application of other power supply equipment not included.

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 normative document (including any amendments) applies.

GB/T 2423.4-2008 Environmental Testing for Electric and Electronic Products - Part 2: Test Method - Test Db: Damp Heat, Cyclic (12 h + 12 h Cycle)

GB/T 2900.1 Electrotechnical Terminology - Fundamental Terms

GB/T 2900.17 Electrotechnical Terminology - Measuring Relays

GB/T 2900.32 Electrotechnical Terminology - Power Semiconductor Parts

GB/T 2900.33 Electrotechnical Terminology - Power Electronics

GB/T 2900.41 Electrotechnical Terminology - Primary and Secondary Cells and Batteries

GB 4208-2008 Degrees of Protection Provided by Enclosure (IP Code)

GB/T 4365 Electrotechnical Terminology - Electromagnetic Compatibility

GB/T 7261-2008 Basic Testing Method for Relaying Protection and Security Automatic Equipment

GB 9254-2008 Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement

GB/T 11287-2000 Electrical Relays - Part 21: Vibration, Shock, Bump and Seismic Tests on Measuring Relays and Protection Equipment - Section One: Vibration Tests (Sinusoidal)

GB/T 14537-1993 Shock and Bump Tests on Measuring Relays and Protection Equipment

GB/T 17626.2-2006 Electromagnetic Compatibility - Testing and Measurement Techniques - Electrostatic Discharge Immunity Test

GB/T 17626.3-2006 Electromagnetic Compatibility - Testing and Measurement Techniques - Radiated Radio-frequency Electromagnetic Field Immunity Test

GB/T 17626.4-2008 Electromagnetic Compatibility - Testing and Measurement Techniques - Electrical Fast Transient/Burst Immunity Test

GB/T 17626.5-2008 Electromagnetic Compatibility - Testing and Measurement Techniques - Surge (Impact) Immunity Test

GB/T 17626.6-2008 Electromagnetic Compatibility - Testing and Measurement Techniques - Immunity to Conducted Disturbances, Induced by Radio-frequency Fields

GB/T 17626.8-2006 Electromagnetic Compatibility - Testing and Measurement Techniques - Power Frequency Magnetic Field Immunity Test

GB/T 17626.10-1998 Electromagnetic Compatibility - Testing and Measurement Techniques - Damped Oscillatory Magnetic Field Immunity Test

GB/T 17626.12-1998 Electromagnetic Compatibility - Testing and Measurement Techniques - Oscillatory Waves Immunity Test

GB/T 19582 (all Parts) Modbus Industrial Automation Network Specification

DL/T 634.5104-2009 Telecontrol Equipment and Systems - Part 5-104: Transmission Protocols - Network Access for IEC 60870-5-101 Using Standard Transport Profiles

DL/T 860 (all Parts) Communication Networks and Systems in Substations

JB/T 5777.2-2002 General Specification for Control and Protection Panel (cabinet, desk) of Secondary Circuit of Power System

JB/T 5777.3-2002 Basic Testing Method for Control and Protection Panel (Cabinet,

The working process of maintaining the charging current from the charging unit to the storage battery at constant value within the range of charging voltage.

3.6

Floating charge

The constant voltage charge for storage battery at the floating charge voltage value. Under normal operation, the charging unit undertakes constant load and simultaneously conducts additional charge to storage battery set so as to supplement the self-discharge of storage battery.

3.7

Equalizing charge

The charge carried out to compensate the uneven voltage generated in the using process and recover the voltage to the specified range.

3.8

Ripple factor

The ratio of half of the difference between the peak and valley of pulse DC electric quantity to the absolute value of DC component.

4 Product model and basic parameters

4.1 Product model and implication

The classification and naming of products are specified in the enterprise product standard. It is recommended to formulate the product model with the method specified below; the function not configured shall not be reflected in the model. During the separate production of the charging unit and feed panel of product, the model is formulated according to the requirements of relevant standard.

- The DC rated current is expressed in Arabic numerals, A;
- The nominal voltage of DC system is expressed in Arabic numerals, V; generally, 220 V, 110 V, 48 V and 24 V are adopted;
- The design No. is expressed in Arabic numerals, letters, etc.; its number of bits and implication are specified in the enterprise product standard;
- DC power supply type: Z - DC power supply; Y - integrated power supply;
- The structural type of equipment is expressed with the following letters: P - panel; G - cabinet.

4.2 Product specifications and parameters

4.2.1 Rated voltage and frequency of AC input

Three-phase voltage: 380 V, 50 Hz;

Single-phase voltage: 220 V, 50 Hz.

4.2.2 Nominal voltage and frequency of AC output

Three-phase voltage: 380 V, 50 Hz;

Single-phase voltage: 220 V, 50 Hz.

4.2.3 DC nominal voltage

220 V, 110 V, 48 V and 24 V.

4.2.4 Output DC rated current of charging unit

As for the output DC rated current of charging unit, the following values may be preferred:

5 A, 10 A, 20 A, 30 A, 40 A, 50 A, 60 A, 80 A, 100 A, 160 A, 200 A, 250 A, 315 A (300 A), 400 A and 500 A.

4.2.5 Rated capacity of storage battery

As for the rated capacity of storage battery, the following values may be preferred:

10 Ah, 20 Ah, 40 Ah, 65 Ah, 80 Ah, 100 Ah, 150 Ah, 200 Ah, 250 Ah, 300 Ah, 350 Ah, 400 Ah, 500 Ah, 600 Ah, 800 Ah, 1 000 Ah, 1 500 Ah, 2 000 Ah, 2 500 Ah and 3 000 Ah.

4.2.6 Boundary dimensions of products

disconnected, and the output frequency shall not exceed (50 ± 0.2) Hz.

5.2.2.5 Voltage imbalance

The voltage imbalance of AC uninterruptible power supply with three-phase output shall not be larger than 5 %.

5.2.2.6 Voltage phase deviation

The voltage phase deviation of AC uninterruptible power supply with three-phase output shall not exceed 3°.

5.2.2.7 Distortion of voltage waveform

The distortion of output waveform shall not exceed 3 %.

5.2.2.8 Output current peak factor

If the input voltage and load capacity are of the rated values, the output current peak factor shall not be less than 3:1.

5.2.2.9 Ripple voltage for current flowing backward

Under inverter output state, the root mean square value of ripple voltage for DC bus current flowing backward shall not exceed 0.5 % of DC bus voltage.

5.2.2.10 Total switching time

The total switching time shall meet the following requirements:

a) Cold standby mode: the time for switching bypass output to inverter output shall not be larger than 10 ms. The time for switching inverter output to bypass output shall not be larger than 4 ms.

b) Double switching time: the time for mutual switching between AC power supply and DC power supply shall be 0 ms. The time for mutual switching between bypass output and inverter output shall not be larger than 4 ms.

5.2.2.11 Requirements for AC bypass input

5.2.2.11.1 Isolation transformer of AC bypass input

Where isolation transformer of AC input is equipped, the input isolation transformer shall meet the following requirements:

a) Insulation resistance: shall not be less than 10 MΩ;

b) Power-frequency withstand voltage: shall be able to bear the 3 kV power

5.2.3.1 Type and DC nominal voltage

5.2.3.1.1 DC switching power supply device shall be high-frequency switch modular type.

5.2.3.1.2 The DC output nominal voltage of this device is 48 V.

5.2.3.2 Stabilized voltage precision

DC input voltage varies within the upper and lower limits specified in Table 2, the output current varies within 5 % ~ 100 % of the rated value and the stabilized voltage precision shall not exceed ± 0.6 %.

5.2.3.3 Dynamic voltage transient range and transient response recovery time

Dynamic voltage transient range shall not exceed ± 5 % of the nominal voltage and the transient response recovery time shall not be larger than 200 ms.

5.2.3.4 Noise voltage

5.2.3.4.1 Telephone weighted noise voltage

The telephone weighted noise voltage at DC output terminal of DC switching power supply device is not larger than 2 mV.

5.2.3.4.2 Broadband noise voltage

The broadband noise voltage at DC output terminal of DC switching power supply device within 3.4 ~ 150 kHz frequency band shall not be larger than 50 mV and that within 0.15 ~ 30 MHz frequency band shall not be larger than 20 mV.

5.2.3.4.3 Discrete frequency noise voltage

The discrete frequency noise voltage at DC output terminal of DC switching power supply device within 3.4 ~ 150 kHz frequency band shall not be larger than 5 mV; that within 0.15 ~ 0.2 MHz frequency band shall not be larger than 3 mV; that with 0.2 ~ 0.5 MHz frequency band shall not be larger than 2 mV and that with 0.5 ~ 30 MHz frequency band shall not be larger than 1 mV.

5.2.3.4.4 Peak-to-peak value noise voltage

The output peak-to-peak value noise voltage at DC output terminal of DC switching power supply device is not larger than 200 mV.

5.2.3.5 Ripple voltage for current flowing backward

The root mean square value of ripple voltage for DC bus current flowing backward from DC switching power supply device shall not exceed 0.5 % of DC bus voltage.

the test, the pole column shall be free from fusing and the appearance shall be free from abnormality.

5.2.5 DC power supply capability

5.2.5.1 DC bus voltage

The maximum variation range of control bus voltage is (85 % ~ 110 %) of the DC system nominal voltage; that of power bus voltage is (87.5 % ~ 112.5 %) of the DC system nominal voltage.

5.2.5.2 Switching impulse discharge test

The products shall be subject to this test where required by the user and see Annex A for the specific requirements.

5.2.5.3 DC bus continuous power supply

In the case of normal operation mode, AC power supply interruption or charging unit failure, the DC bus shall continuously supply power.

5.2.5.4 Voltage regulation function of control bus

Where the DC bus is equipped with voltage regulator, the voltage regulator shall be provided with manual and automatic voltage regulation function, in the regulating process or in case that the voltage regulator fails, the DC control bus shall continuously supply power.

5.2.6 Noise

Where the surrounding ambient noise is not larger than 40 dB, the noise of self-cooling product shall not be larger than 55 dB (sound level A); the noise of air-cooling product shall not be larger than 60 dB (sound level A) under 50 % or less of the rated load and shall not be larger than 65 dB (sound level A) under 50 % or more of the rated load.

5.2.7 Protection and alarm

5.2.7.1 Insulation supervision requirements

The product shall be provided with insulation supervision function. Where the DC system is subject to earthing failure or the insulation level drops to the set value, the insulation supervision device shall send out correct signal and be provided with appropriate remote signal contact.

Where multiple branch circuits or multi-section buses are tested, independent device should be equipped.

5.2.7.5.2 AC uninterruptible power supply and inverter supply

Requirements for AC uninterruptible power supply and inverter supply:

a) Where the output power exceeds 105 % ~ 125 % of the rated value and the operation time is larger than or equal to 10 min, it is automatically switched to the bypass, after the overload is eliminated, it shall be able to recover the work automatically;

b) Where the output power exceeds 125 % ~ 150 % of the rated value and the operation time is larger than or equal to 1 min, it is automatically switched to the bypass, after the overload is eliminated, it shall be able to recover the work automatically;

c) Where the output power exceeds 150% of the rated value or it is subject to short circuit, it shall be switched to the bypass immediately. The by-pass switch shall be provided with adequate overload capability and the distribution switch shall be tripped at first, after the overloading is eliminated, it shall be able to recover the work automatically. In principle, the rated current of distribution switch shall not be larger than 50 % of the rated output current of device.

5.2.7.6 Failure alarm requirements

In case of the following conditions, the product shall be able to send out alarm signal and be provided with remote signal contact:

a) DC power supply alarm signal:

1) AC input overvoltage, undervoltage and phase loss;

2) AC output overvoltage and undervoltage;

3) Failure of float charging unit;

4) DC bus overvoltage and undervoltage;

5) Failure of DC bus insulation;

6) Overvoltage and undervoltage of storage battery set;

7) Fuse fusing or circuit-breaker tripping at outlet of storage battery set;

8) Tripping of feeder circuit-breaker;

9) Failure of insulation supervision device.

b) Alarm signal of AC uninterruptible power supply;

5.2.9.2 Remote measuring function

The monitoring device of product shall be able to collect and send DC bus voltage, output voltage and current of charging unit, voltage and current of storage battery set, AC input power supply voltage, output voltage, current and frequency of AC uninterruptible power supply and inverter supply devices and output voltage and current of DC switching power supply device through communication interface.

5.2.9.3 Remote signaling function

The monitoring device of product shall be able to collect and send DC bus overvoltage and undervoltage signals, DC bus insulation degradation signal, operation state and failure of charging unit, AC power failure, fusing of storage battery fuse wire and storage battery discharge undervoltage signals, the operation state and abnormality of AC uninterruptible power supply and inverter supply devices, tripping of AC feeder circuit-breaker, abnormality of DC switching power supply device, tripping of feeder circuit-breaker, monitoring device failure and abnormality of monitoring communication.

5.2.9.4 Remote control function

The monitoring device of product shall be able to receive and execute remote control signal, control the conversion of equalized charging and floating charging operation modes.

5.2.10 Requirements for product charging function

5.2.10.1 The charging operation characteristics of product shall meet the requirements for normal operation of storage battery.

5.2.10.2 The product with program control function shall be equipped with charge, long-term operation and AC interruption control procedure and its operation control mode shall meet the requirements for product operation. Refer to Annex C for the operation curve.

5.2.11 Influence of temperature variation to the performance

The product shall be able to work normally when its temperature varies within the range specified in Table 1 and it shall meet the following requirements:

a) Requirements for DC voltage deviation: when the charging unit works under stabilized voltage, the output voltage deviation shall not exceed ± 0.5 %.

b) Requirements for stabilized voltage precision: the output stabilized voltage precision of charging unit shall not exceed those specified in Table 3.

5.2.12 Requirements for product configuration

in JB/T 5777.2-2002.

5.4 Requirements for electromagnetic compatibility

5.4.1 Immunity requirement

5.4.1.1 Oscillatory wave immunity

The product shall be able to withstand the oscillatory wave immunity tests at 1 MHz and 100 kHz of Severity Level 3 as specified in Clause 5 of GB/T 17626.12-1998.

5.4.1.2 Electrostatic discharge immunity

The product shall be able to withstand the electrostatic discharge immunity test at Severity Level 3 as specified in Clause 5 of GB/T 17626.2-2006.

5.4.1.3 Radio-frequency electromagnetic field radiation immunity

The product shall be able to withstand the radio-frequency electromagnetic field radiation immunity test at Severity Level 3 as specified in Clause 5 of GB/T 17626.3-2006.

5.4.1.4 Electrical fast transient burst immunity

The product shall be able to withstand the electrical fast transient/burst immunity test at Severity Level 3 as specified in Clause 5 of GB/T 17626.4-2008.

5.4.1.5 Surge (impulse) immunity

The product shall be able to withstand the surge (impact) immunity test at Severity Level 3 as specified in Clause 5 of GB/T 17626.5-2008.

5.4.1.6 Immunity to radio-frequency field-induced conducted disturbance

The product shall be able to withstand the immunity test to radio-frequency field-induced conducted disturbance at Severity Level 3 as specified in Clause 5 of GB/T 17626.6-2008.

5.4.1.7 Power frequency magnetic field immunity

The product shall be able to withstand the power frequency magnetic field immunity test at Severity Level 4 as specified in Clause 5 of GB/T 17626.8-2006. The products for ultra-high voltage system shall be able to withstand the power frequency magnetic field immunity test at Severity Level 5 as specified in Clause 5 of GB/T 17626.8-2006.

5.4.1.8 Damped oscillation magnetic field immunity

The product shall be able to withstand the damped oscillation magnetic field immunity

6 Test method

6.1 Test conditions

6.1.1 Ambient conditions

Unless otherwise specified, tests shall be carried out under normal ambient conditions which refer to:

a) Ambient temperature: +15 °C ~ +35 °C;

b) Relative humidity: 45 % ~ 75 %;

c) Atmospheric pressure: 86 kPa ~ 106 kPa.

6.1.2 Test power supply requirements

The test power supply requirements include:

a) AC power supply frequency: 50 Hz ± 0.5 Hz;

b) AC power supply wave form: sine wave with waveform distortion factor not greater than 5 %;

c) DC component of AC power supply system: the offset shall not be larger than 2 % of the peak.

d) AC component (ripple) of DC power supply: not larger than 6 %;

e) Imbalance of AC power supply system: not larger than 5 %.

6.1.3 Terms of arbitration

Dispute, if any, may be subjected to arbitration according to the reference conditions specified in 4.1 and 4.2 of GB/T 7261-2008.

6.1.4 Test instrument requirements

Unless otherwise specified, the precisions of all instruments and apparatus used during tests shall meet the following requirements:

a) The precision of common instrument shall be selected according to Table 14 based on the measured error rating;

b) The instrument for measuring phase shall not be less than Class 1.0;

c) The error of the instrument for measuring temperature shall not be larger than ±

Figure 1 -- Circuit diagram for stabilized current precision, stabilized voltage precision and ripple factor tests

6.3.2 Stabilized current precision test

6.3.2.1 With the charging unit at constant current charging state, the charging current set to any point within the set range specified in Table 2, the AC input voltage varying within (85 % ~ 120 %) of the rated value (the reading of voltmeter 2PV), adjust the charging voltage to make it vary within the variation range specified in Table 2 and measure the charging current respectively (the reading shown by amperemeter 1PA), find out the extreme value I_M of charging current within the said variation range.

6.3.2.2 The stabilized current precision shall be calculated according to Formula (1) and the calculation result shall meet the requirements of 5.2.1.2:

$$\delta_I = \frac{I_M - I_Z}{I_Z} \times 100\% \qquad \cdots\cdots (1)$$

where,

δ_I - the stabilized current precision;

I_Z - the charging current measured when the AC input voltage is the rated value and the charging voltage is the median value of the variation range;

I_M - the extreme value of charging current.

6.3.3 Stabilized voltage precision test

6.3.3.1 With the charging unit at stabilized voltage state, the DC output voltage set to any point within the set range specified in Table 2, the AC input voltage varying within (85 % ~ 120 %) of the rated value (the reading of voltmeter 2PV), adjust the load current to (0 ~ 100) % of the rated value (the reading of amperemeter 1PA) and measure the output voltage respectively (the reading shown by voltmeter 1PV), find out the extreme value U_M of charging unit output voltage within the said variation range.

6.3.3.2 The stabilized voltage precision shall be calculated according to Formula (2) and the calculation result shall meet the requirements of 5.2.1.2:

$$\delta_U = \frac{U_M - U_Z}{U_Z} \times 100\% \qquad \cdots\cdots (2)$$

where,

δ_U - the stabilized voltage precision;

$$\delta_I = \frac{I_Z - I_{Z0}}{I_{Z0}} \times 100\% \quad \cdots\cdots (4)$$

where,

δ_I - the set error of current;

I_Z - the charging current measured when the AC input voltage is the rated value and the charging voltage is the median value of the variation range;

I_{Z0} - the set value of charging current.

6.4.2 DC output voltage set error test

6.4.2.1 With the charging unit at stabilized voltage state, the DC output voltage set to any point within the set range specified in Table 2, the AC input voltage at the rated value (the reading of voltmeter 2PV), adjust the load current to 50 % of the rated value (the reading of amperemeter 1PA) and respectively measure the output voltage U_Z (the reading shown by voltmeter 1PV).

6.4.2.2 The set error shall be calculated according to Formula (5) and the calculation result shall meet the requirements of 5.2.1.3:

$$\delta_U = \frac{U_Z - U_{Z0}}{U_{Z0}} \times 100\% \quad \cdots\cdots (5)$$

where,

δ_U - the set error of voltage;

U_Z - the output voltage measured when the AC input voltage is the rated value and the load current is 50 % of the rated current;

U_{Z0} - the set value of output voltage.

6.5 Tests on voltage and current limiting characteristics

6.5.1 When the charging unit operates under constant current charging state, adjust the load resistance to increase the DC output voltage; when the output voltage exceeds the voltage limiting set value, it shall be able to automatically limit the increase of DC output voltage.

6.5.2 When the charging unit operates at stabilized voltage, adjust the load resistance to gradually increase the output current to exceed the current-limiting set value, the charging unit will limit the DC output current automatically. When the output current decreases to below the limit value, it shall be able to resume work automatically.

Under the test conditions specified in 6.9.2, use the storage oscilloscope to test the duration from the sudden change of output voltage to recovery within the stabilized voltage precision range when the load current changes suddenly and when the AC and DC input power supply switch mutually; the results shall meet the requirements of 5.2.2.2.

6.9.4 Synchronization precision test

Set the bypass input be the standard sine wave and connect the UPS output with the resistive rated load. After UPS and bypass input get synchronous, use storage oscilloscope to measure the phase difference between the bypass input waveform and UPS output waveform. Calculate the synchronization precision according to Formula (10) and the result shall meet the requirements of 5.2.2.3:

$$t_j = \frac{\theta}{360^\circ} \times 100\% \qquad \cdots\cdots (10)$$

where,

t_j - the synchronization precision;

θ - the input and output phase difference (°).

6.9.5 Output frequency test

Disconnect the UPS or INV bypass input; at resistive rated load, the output frequency shall meet the requirements of 5.2.2.4.

6.9.6 Voltage imbalance test

Input rated voltage and frequency; measure the phase voltage of three-phase output under symmetrical and unsymmetrical resistive loads respectively, and calculate the voltage imbalance. Symmetrical load is three phase plus rated load; while unsymmetrical load is two full-load phases and one no-load phase. The measurement results shall meet the requirements of 5.2.2.5.

6.9.7 Voltage phase deviation test

Connect UPS three-phase output with balanced resistive rated load; measure the phase angle of the phase voltage of three-phase output and the measurement deviation shall meet the requirements of 5.2.2.6.

6.9.8 Voltage waveform distortion test

Test under AC input and DC input. When the power supply is under inverter output working state, as well as no-load, resistive rated load and nonlinear rated load (three-phase balanced load) conditions, the output voltage waveform distortion shall meet the

requirements of 5.2.2.7.

6.9.9 Output current peak factor

Test at rated AC/DC input voltage respectively. Connect the power under inverter output working state with non-linear load (balanced load), and adjust the peak current of non-linear load so that the power supply maintains rated output; measure the peak value of output current IP and root-mean-square value I_R. The output current peak factor $F = I_P/I_R$ shall meet the requirements of 5.2.2.8.

6.9.10 Ripple voltage flowing backward

Under inverter output working state, the power is supplied by DC bus input and the storage battery set is under floating charge state; the device under test outputs rated voltage and rated current. Use True RMS meter to measure the root-mean-square value of ripple voltage at the inlet of the storage battery set of integrated power supply equipment; calculate the ripple voltage factor according to Formula (11) and the result shall meet the requirements of 5.2.2.9:

$$\delta_{rms} = \frac{U_{rms}}{U_d} \times 100\% \qquad \cdots\cdots (11)$$

where,

δ_{rms} - the ripple voltage factor;

U_{rms} - the root-mean-square value of ripple voltage;

U_d - the average DC voltage.

6.9.11 Test on total switching time

Under rated input and resistive rated load (three-phase balanced load) conditions, manually simulate various switching situations and record the output voltage waveform with storage oscilloscope; the switching time shall meet the requirements of 5.2.2.10.

6.9.12 AC bypass input test

6.9.12.1 The insulation resistance, power-frequency withstand voltage and impulse voltage between transformer winding and iron core, as well as those between input winding and output winding shall meet the requirements of 5.2.2.11.

6.9.12.2 In case of 85 % ~ 120 % of rated AC input voltage and resistive rated load (three-phase balanced load), the regulation scope and stabilizing precision of output voltage shall meet the requirements of 5.2.2.11.

6.9.12.3 In case of long-term operation under rated condition and 30min-operation

under 150 % overload condition, the temperature rise shall meet the requirements of 5.3.5.

6.9.13 Efficiency test

Connect the output with resistive rated load under rated AC/DC input conditions respectively and measure the conversion efficiency, which shall meet the requirements of 5.2.2.12.

6.9.14 Input power factor test

Connect the output with rated load under rated AC input condition and measure the input power factor, which shall meet the requirements of 5.2.2.13.

6.9.15 Parallel current share test

With the power input being the rated value and output load current being 50 % and 100 % (three-phase balanced load) of rated value respectively, measure the AC output current of each cell and calculate the imbalance of load current according to Formula (8) which shall meet the requirements of 5.2.2.14.

6.10 DC switching power supply unit

6.10.1 Stabilized voltage precision test

The DC input voltage varies between the extreme values that are specified in Table 2; the output current varies between 5 % ~ 100 % of rated value; the output voltage keeps stable at any value within the range of 100 % ~ 110 % of nominal voltage; test the output voltage at the output terminal and calculate the stabilized voltage precision according to Formula (2), which shall meet the requirements of 5.2.3.2.

6.10.2 Test on dynamic voltage transient range

6.10.2.1 Under rated input voltage and rated output voltage, the load current undergoes "25 % - 50 % - 25 %" and "50 % - 75 % - 50 %" (of rated value) step changes; measure the DC output voltage waveform with storage oscilloscope and the overshoot shall meet the requirements of 5.2.3.3.

6.10.2.2 As the input voltage surges from 0 to the rated value, measure the DC output voltage waveform with storage oscilloscope and the overshoot shall meet the requirements of 5.2.3.3.

6.10.3 Test on transient response recovery time

Under the test conditions specified in 6.10.2, use the storage oscilloscope to test the duration from the sudden change of output voltage to recovery within the stabilized voltage precision range, and the measurement result shall meet the requirement of

Keys:
R - Adjustable resistor;
1PA - DC amperemeter;
2PA - DC amperemeter;
1PV - DC voltmeter;
2PV - DC voltmeter;
3PV - AC voltmeter.

Figure 4 -- Batter capacity test wiring diagram

6.11.1.2 After the storage battery is fully charged, the charging unit stops working and then the discharge loop shall be connected.

6.11.1.3 Adjust the resistance R to make its discharge current (the value indicated on amperemeter 2PA) to the specified value and measure the voltage of single storage battery and storage battery set (the value indicated on voltmeter 2PV) respectively.

6.11.1.4 Calculate the capacity of storage battery set according to the duration from starting to ending of charging of any single battery. When the result is converted to 25 °C, the capacity of storage battery set shall meet the requirements of 5.2.4.1.

6.11.1.5 The storage battery set is allowed to undergo three consecutive charge-discharge cycles and the capacity shall meet the requirements.

6.11.2 Large current discharge capability test

Carry out this test after the test specified in 6.11.1 has been passed. Charge the storage battery to full and discharge successively according to the current and time specified in 5.2.4.2, and then inspect the pole and appearance of storage battery; the conductive part shall not be fused, and the appearance shall be free from abnormality and obvious deformation.

6.12 DC supply capacity test

6.12.1 Switching impulse discharge test

This test is carried out for products according to Annex A as required.

6.12.2 DC bus continuous supply test

In the floating charge state, switch off the AC power supply for 500 ms ~ 1 000 ms and record the oscillogram throughout the process of interruption and restoration of AC power supply. The DC bus shall supply continuously, and the voltage shall meet the requirements of 5.2.5.1.

6.12.3 Control bus voltage regulation function test

For products equipped with silicon-chain voltage regulator or other types, manual/automatic voltage regulating test is carried out:

a) Manual voltage regulating test: with the power bus voltage keeping unchanged, the control bus voltage will change once the voltage is regulated manually by levels until equating with the power bus voltage and the test result shall meet the requirements of 5.2.5.4.

b) Automatic voltage regulating test: when the power bus voltage decreases continuously from the peak or increases gradually to the peak from the minimum, the automatic voltage regulator can keep the control bus voltage within the setting range and its test result shall meet the requirements of 5.2.5.4.

6.13 Noise test

Provided that the AC input voltage and output load are rated, and the ambient noise is not greater than 40 dB, measure the product noise at the point of 1 m from the noise source horizontally and 1 m ~ 1.5 m from the ground. For air-cooled products, adjust the load to 50 % of the rated value and measure the product noise. The measured noise shall meet the requirements of 5.2.6.

6.14 Protection and warning function test

6.14.1 Insulation supervision requirements test: simulate the insulation reduction failure and observe the operation and contact output of insulation supervision device, which shall meet the requirements of 5.2.7.1.

6.14.2 Voltage supervision requirements test: adjust the bus voltage and observe the operation and contact output of voltage supervision device, which shall meet the requirements of 5.2.7.2.

6.14.3 Flashing alarm requirements test: observe the operation and corresponding configuration of flashing signal device, which shall meet the requirements of 5.2.7.3.

6.14.4 Overvoltage and undervoltage protection test: separately adjust the input voltage to overvoltage and undervoltage, and observe the operation of product; separately adjust the output voltage to overvoltage and undervoltage, and observe the operation of product. In the overvoltage and undervoltage state, the product shall meet the requirements of 5.2.7.4.

6.14.5 Overload and short-circuit protection test: simulate the overload and short-circuit failure, and observe the product operation state, which shall meet the requirements of 5.2.7.5.

6.14.6 Failure alarm requirements test: simulate the failure and observe the failure alarm and contact output, which shall meet the requirements of 5.2.7.6.

6.15 Monitoring function test

The monitoring function is tested according to the following method:

a) General function test: inspect the general functions of monitoring device, which shall meet the requirements of 5.2.8.1;

b) Control function test: inspect the control functions of monitoring device, which shall meet the requirements of 5.2.8.2;

c) Display and detection function test: inspect the detection precision and period of monitoring device, which shall meet the requirements of 5.2.8.3;

d) Protection and failure management: inspect the failure information processing of monitoring device, which shall meet the requirements of 5.2.8.4.

6.16 Communication function test

6.16.1 Connect the product's communication interface with the analog master station to carry out communication function test.

6.16.2 The product's communication protocol testing is carried out according to the method specified in relevant standard and the communication protocol shall meet the requirements of 5.2.9.1.

6.16.3 As for remote measuring function test, the master station connected with communication interface shall be able to properly receive the parameters in the current operation state and shall meet the requirements of 5.2.9.2.

6.16.4 As for remote signaling function test, simulate various failures and actuating signals; the master station connected with product's communication interface shall be able to properly receive various corresponding alarm signals and signals indicating equipment operation state, and shall meet the requirements of 5.2.9.3.

6.16.5 As for remote control function test, the master station connected with communication interface shall be able to convert the working state of equipment and shall meet the requirements of 5.2.9.4.

6.17 Product's charging function test

6.17.1 The test connection is as shown in Figure 5.

6.20.2 Inspect the insulation resistance of 5.3.2 according to the method specified in 12.1 of GB/T 7261-2008, which shall meet the requirements of 5.3.2.

6.20.3 Inspect the dielectric strength of 5.3.3 according to the method specified in 12.2 of GB/T 7261-2008, which shall meet the requirements of 5.3.3.

6.20.4 Inspect the impulse voltage of 5.3.4 according to the method specified in 12.3 of GB/T 7261-2008, which shall meet the requirements of 5.3.4.

6.20.5 Inspect the temperature rise of 5.3.5 according to the method specified in Clause 8 of GB/T 7261-2008, which shall meet the requirements of 5.3.5.

6.20.6 Inspect the heat and humidity resistance of 5.3.6 according to the method specified in GB/T 2423.4-2008, which shall meet the requirements of 5.3.6.

6.20.7 Inspect the product protection grade of 5.3.7 according to the method specified in GB 4208-2008, which shall meet the requirements of 5.3.7.

6.20.8 Inspect the electric shock protection measures of 5.3.8, measure the earthing resistance with bridge, earthing resistance tester or digital low-resistance tester and inspect the electric shock protection measures, which shall meet the requirements of 5.3.8.

6.21 Immunity test

6.21.1 Inspection result and acceptance judgment

6.21.1.1 Inspection result

In the immunity test, the following four results are possible:

a) The performance is normal within the technical specification;

b) The function or performance is temporarily reduced or lost, but can recover automatically;

c) The function or performance is temporarily reduced or lost, and requires the operator intervention or system reset;

d) The function is reduced or lost and cannot recover automatically since the equipment (component) or software is damaged, or the data is lost.

6.21.1.2 Acceptance judgment

Acceptance judgment is as follows:

a) The test is deemed acceptable if the result in a) or b) of 6.21.1.1 is obtained;

current is respectively the rated current (resistive load) and 0.5 times the rated current (resistive load).

6.22.2 Acceptance judgment

It is deemed as acceptable if the electromagnetic emission limit does not exceed those specified in Table 11 and Table 12; otherwise, it is deemed as rejected.

6.22.3 Conducted emission limit test

Inspect the conducted emission limit of 5.4.2.1 according to the method specified in GB 9254-2008 and test the AC input end.

6.22.4 Radiated emission limit test

Inspect the radiated emission limit of 5.4.2.1 according to the method specified in GB 9254-2008.

6.22.5 Harmonic current limit test

Provided that the product is in the floating charge state and the DC output current is rated, measure the percentage of 2th ~ 19th harmonic current at the AC input side of charging unit, which shall meet the requirements of 5.4.2.2.

7 Inspection rules

7.1 General requirements

The product inspection consists of delivery inspection and type inspection.

7.2 Delivery inspection

7.2.1 All products shall be subject to delivery inspection and can be delivered after passing the inspection and provided with the delivery certificate.

7.2.2 The delivery inspection items are detailed in Table 15.

7.3 Type inspection

7.3.1 Under the following conditions, type inspection shall be carried out:

a) For the newly designed products (including transfer-plant production) prior to type approval;

b) For the series products (once every four years);

c) After the product is put into production, if any great change of design,

d) Record the discharging current and voltage, and calculate the voltage of storage battery set;

e) Carry out the test three times at an interval of 2 s.

A.3.3 In case of an emergency, the impulse current discharge capability test is carried out as follows:

a) Fill the storage battery according to charge requirements and shift to floating charge for 1 h, then the charging unit stops;

b) Adjust R1 to make its discharging current reach the specified value, switch on 3K and maintain the discharging current constant within the specified discharging time;

c) Adjust R2 to make its discharging time current superpose to the specified impulse current;

d) Switch on 2K to make the impulse discharging time current last for 500 ms;

e) Record the discharging current and voltage, and calculate the voltage of storage battery set;

f) Carry out the test three times at an interval of 2 s.

A.3.4 During normal operation, the impulse current discharge capability test is carried out as follows:

a) Fill the storage battery according to charge requirements and shift to floating charge for 1 h;

b) Keep the control bus at regular load current;

c) Connect the impulse load with switching (power) bus, adjust R2 to discharge the impulse current in the emergency state;

d) Switch on 2K to make the impulse discharge current last for 500 ms;

e) Record the discharging current and voltage in a test, and calculate the voltage of storage battery set.

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