***भारतीय मानक***

***Indian Standard***

**IS……….2024**

**IEEE Std 1547-2018**

एसोसिएटेड इलेक्ट्रिक पावर सिस्टम इंटरफेस के साथ वितरित ऊर्जा संसाधनों का अंत:

संबधन और अन्तरसंक्रियता

Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power

Systems Interfaces

ICS 29.240.01

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भारतीय मानक ब्यूरो

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Grid Integration of Renewables Sectional Committee, ETD 46

NATIONAL FOREWORD

This Indian Standard which is identical with International Publication IEEE Std 1547-2018 ‘IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces’ issued by The Institute of Electrical and Electronics Engineers was adopted by the Bureau of Indian Standards on the recommendation of the Grid Integration of Renewables Sectional Committee and approval of the Electrotechnical Division Council.

This Indian National Standard is made available under license from IEEE and is an adoption of IEEE Std 1547-2018 ‘IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces’, 445 Hoes Lane Piscataway, NJ, 08854, USA.

This Indian National Standard is only valid in India as an Indian National Standard. No changes have been made to the adopted IEEE Standard except those that may be included as Country-Specific Changes in a front matter or an attached informative annexure. India specific changes have been made to the adopted IEEE standard as outlined in National Annexure A.

The text of IEEE Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminology and conventions are however not identical to those used in Indian Standards. Attention is particularly drawn to the following:

Wherever the words ‘IEEE Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.

In this adopted standard, references appear to the following International Standards for which Indian Standards also exist. The corresponding Indian Standard which is to be substituted in place, is listed below along with their degree of equivalence for the editions indicated:

|  |  |  |
| --- | --- | --- |
| *International Standard* | *Corresponding Indian Standard* | *Degree of Equivalence* |
| IEC 61000-4-3, Electromagnetic compatibility (EMC)—Part 4-3: Testing and measurement techniques— Radiated, radio-frequency, electromagnetic field immunity test | IS 14700 (Part 4/Sec 3) : 2018 Electromagnetic Compatibility (EMC) Part 4 Testing and Measurement Techniques Section 24 Test methods for protective devices for HEMP conducted disturbance ( First Revision ) | Identical with IEC 61000-4-3 |
| IEC 61000-4-5, Electromagnetic compatibility (EMC)—Part 4-5: Testing and measurement techniques— Surge immunity test. | IS 14700 (Part 4/Sec 5) : 2019 Electromagnetic compatibility (EMC):  Part 4 testing and measurement techniques: Sec 5 surge immunity test (First Revision) | Identical with |
| IEC 61000-4-5: |
| 2017 |
|  |
|  |

The technical committee has reviewed the provisions of the following International Standards/Other Publications referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

|  |  |
| --- | --- |
| *International Standard* | *Title* |
| ANSI C84.1 | Electric Power Systems and Equipment—Voltage Ratings (60  Hz).17 |
| IEC/TR 61000-3-7 | Electromagnetic compatibility (EMC)—Part 3-7: Limits— Assessment of emission limits for the connection of fluctuating  installations to MV, HV and EHV power systems.18 |
| IEEE Std 519™ | IEEE Recommended Practices and Requirements for Harmonic  Control in Electrical Power Systems.19, 20 |
| IEEE Std 1453™ | IEEE Recommended Practice for the Analysis of Fluctuating  Installations on Power Systems. |
| IEEE Std 1815™ | IEEE Standard for Electric Power Systems Communications-  Distributed Network Protocol (DNP3). |

**NATIONAL ANNEXURE A**

(*National Foreword*)

(Normative)

**A-1** This IEEE standard specifies the frequency as 60Hz for standard testing condition. However, as per Indian conditions, the frequency shall be considered as 50Hz.

**A-2** Table 2 — Substitute the following for the existing:

**Table 2 Applicable Voltages When PCC Is Located at Low Voltage**

|  |  |  |
| --- | --- | --- |
| **Sl. No.**  (1) | **Low-Voltage Winding Configuration of Area EPS Transformer (S)A**  (2) | **Applicable Voltages**  (3) |
|  | Grounded Wye, | Phase-to-phase and phase-to-neutral, or  Phase-to-phase and phase-to-ground |
|  | Ungrounded Wye, | Phase-to-phase or phase-to-neutral |
|  | Deltab | Phase-to-phase |
|  | Single-Phase | Line to neutral – for 230 V DER units |
|  | Three-Phase | Line to line – for 400 V DER units |

a A three-phase transformer or a bank of single-phase transformers may be used for three-phase systems.

b Including delta with mid tap connection (grounded or ungrounded).

**A-3** Table 3 — Substitute the following for the existing:

**TABLE 3 Minimum Measurement and Calculation Accuracy**

**Requirements for Manufacturersa**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No.**  (1) | **Time Frame** | **Steady-State Measurements** | | | **Transient Measurements** | | |
| **Parameter**  (2) | **Minimum**  **Measurement**  **Accuracy**  (3) | **Measurement**  **Window**  (4) | **Range**  (5) | **Minimum**  **Measurement**  **Accuracy**  (6) | **Measurement**  **Window**  (7) | **Range**  (8) |
|  | Voltage, RMS | (± 1% *V*nom) | 10 cycles | 0.5 p.u. to 1.2 p.u**.** | (± 2% *V*nom) | 5 cycles | 0.5 p.u. to 1.2 p.u. |
|  | Frequencyb | 10 mHz | 50 cycles | 40 Hz to 55 Hz | 100 mHz | 5 cycles | 40 Hz to 55 Hz |
|  | Active Power | (± 5% Srated) | 10 cycles | 0.2 p.u. <*P* <1.0 p.u. | Not required | N/A | N/A |
|  | Reactive  Power | (± 5% Srated) | 10 cycles | 0.2 p.u. <P <1.0 p.u. | Not required | N/A | N/A |
|  | Time | 1% of measured duration | N/A | 5 s to 600 s | 2 cycles | N/A | 100 ms < 5 s |

a Measurement accuracy requirements specified in this table are applicable for voltage THD <2.5% and individual voltage harmonics <1.5%.

b Accuracy requirements for frequency are applicable only when the fundamental voltage is greater than 30% of the nominal voltage.

**A-4** Table 4 — Substitute the following for the existing:

**TABLE 4 Enter Service Criteria for DER of Category I, Category II, and Category III**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl. No.**  (1) | **Enter Service Criteria** | | **Default Settings** | **Ranges Of Allowable Settings** |
| Permit service  (2) | | Enabled  (3) | Enabled/Disabled  (4) |
|  | Applicable voltage  within range | Minimum value | ≥ 0.9 p.u. | 0.8 p.u. to 0.9 p.u. |
|  | Maximum value | ≤ 1.1 p.u. | 1.1 p.u. to 1.2 p.u. |
|  | Frequency within  Range | Minimum value | ≥ 49.5 Hz | 49.0 Hz to 49.9 Hz |
|  | Maximum value | ≤ 50.1 Hz | 50.1 Hz to 51.0 Hz |

**A-5** Substitute the following for the existing Cl. 4.10.3 (b):

DER shall be capable of delaying enter service by an intentional adjustable minimum delay when the Area EPS steady-state voltage and frequency are within the ranges specified in Table 4. The adjustable range of the minimum intentional delay shall be 0 s to 600 s with a default minimum delay of 60 s.

**A-6** Substitute the following for the existing 1st para of Cl. 4.10.4:

The DER shall operate in parallel with the Area EPS without causing step changes in the RMS voltage at the PCC exceeding 5% of nominal when the PCC is at medium voltage, or exceeding 5% of nominal when the PCC is at low voltage.

**A-7** Table 7 — Substitute the following for the existing:

**Table 7 Minimum Reactive Power Injection and Absorption Capability**

|  |  |  |
| --- | --- | --- |
| **Sl. No.**  (1) | **Injection capability as % of nameplate apparent power (kVA) rating** | **Absorption capability as % of nameplate apparent power (kVa) rating** |
| i) | 60 | 60 |

**A-8** Table 8 — Substitute the following for the existing:

**Table 8 Voltage-Reactive Power Settings for Normal Operating Performance Category A and Category B DER**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No.**  (1) | **Voltage-reactive**  **Power parameters**  (2) | **Default settings** | | **Ranges of allowable settings** | |
| Category A  (3) | Category B  (4) | Minimum  (5) | Maximum  (6) |
|  | *V*Ref | VN | VN | 0.9 VN | 1.1 VN |
|  | V2 | VN | *V*Ref – 0.02 VN | Category A: *V*Ref  Category B: *V*Ref – 0.03 VN | *V*Ref c |
|  | *Q*2 | 0 | 0 | 100% of nameplate reactive power capability, absorption | 100% of nameplate reactive power capability, injection |
|  | *V*3 | *V*N | *V*Ref + 0.02 VN | *V*Ref c | Category A: *V*Ref  Category B: *V*Ref + 0.03 VN |
|  | *Q*3 | *0* | *0* | 100% of nameplate reactive power capability, absorption | 100% of nameplate reactive power capability, injection |
|  | *V*1 | 0.9 *V*N | *V*Ref – 0.08 VN | *V*Ref – 0.18 VN | *V*2 – 0.02 VN c |
|  | *Q1 a* | 25% of nameplate  apparent power  rating, injection | 60% of nameplate apparent power rating, injection | *0* | 100% of nameplate  reactive power capability, injectionb |
|  | *V*4 | 1.1 *V*N | *V*Ref + 0.08 *V*N | *V*3+0.02 *V*N c | *V*Ref + 0.18 *V*N |
|  | *Q*4 | 25% of nameplate apparent power rating, absorption | 60% of nameplate apparent power rating, absorption | 100% of nameplate reactive power capability, absorption | *0* |
|  | Open loop response time | 10 s | 5 s | 1 s | 90 s |

aThe DER reactive power capability may be reduced at lower voltage.

bIf needed DER may reduce active power output to meet this requirement.

cImproper selection of these values may cause system instability.

**A-9** Table 9 — Substitute the following for the existing:

**Table 9 —Active Power-Reactive Power Settings for Normal Operating Performance: Category A and Category B DER**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No.**  (1) | **Active Power-Reactive Power Parameters**  (2) | **Default Settings** | | **Ranges Of Allowable Settings** | |
| Category A  (3) | Category B  (4) | Minimum  (5) | Maximum  (6) |
|  | P3 | Prated | | P2 + 0.1Prated | Prated |
|  | P2 | 0.5 Prated | | 0.4 Prated | 0.8 Prated |
|  | P1 | The greater of 0.2 Prated and Pmin | | Pmin | P2 – 0.1 Prated |
|  | P’1 | The lesser of 0.2 P’rated and P’min | | P’2 – 0.1 P’rated | P’min |
|  | P’2 | 0.5 P’rated | | 0.8 P’rated | 0.4 P’rated |
|  | P’3 | P’rated | | P’rated | P’2 + 0.1 P’rated |
|  | Q3 | 25% of nameplate apparent power rating, absorption | 60% of nameplate apparent power rating, absorption | 100% of nameplate reactive power absorption capability | 100% of nameplate reactive power injection capability |
|  | Q2 | 0 | |
|  | Q1 | 0 | |
|  | Q’1 | 0 | |
|  | Q’2 | 0 | |
|  | Q’3 | 60% of nameplate apparent power rating, injection | |
| Note – Prated is the nameplate active power rating of the DER  P’rated is the maximum active power that the DER can absorb  Pmin is the minimum active power output of the DER  P’min is the minimum, in amplitude, active power that the DER can absorb  P’ parameters are negative in value | | | | | |

**A-10** Table 11, Table 12, Table 13: Substitute the following for the existing:

**Table 11, Table 12 and Table 13: DER response (shall trip) to abnormal voltages for DER of abnormal operating performance**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.**  (1) | **Shall Trip Function**  (2) | **Ranges Of Allowable Settings** | |
| **Voltage (P.U. Of Nominal Voltage)**  (3) | **Clearing Time (S)** |
|  | Overvoltage | V > 1.1 | 2 s |
|  | Undervoltage | V < 0.8 | 2 s |

**A-11** Table 18- Substitute the following for the existing:

**Table 18 – DER response (shall trip) to abnormal frequencies for DER of abnormal operating performance Category I, Category II, and Category III (see Figure H.10)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Shall function**  (2) | **Default settings** | | **Ranges of allowable settings** | |
| (1) | **Frequency (Hz)**  (3) | **Clearing time (s)**  (4) | **Frequency (Hz)**  (5) | **Clearing time (s)**  (6) |
|  | OF | 52.0 | 0.2 | 50.05 - 52.0 | 0.16-1000 |
|  | UF | 47.5 | 0.2 | 47.5 - 48.8 | 0.16-1000 |

**A-12** Substitute the following for the existing Cl. 6.5.2:

The DER shall continue normal operation within the frequency range of 47.5 Hz to 52 Hz. For Over Frequency (OF) events in the 50.05 Hz to 52.0 Hz, the DER shall continue operating and shall adjust the generated power to additional requirements of the Central Electricity Authority (CEA). In the absence of Central Electricity Authority requirements, the DER operator shall operate according to the requirements of the connected Area EPS, distribution license.