PQS Independent type-testing protocol

TITLE: Single-phase voltage stabilizer for ac powered refrigerators and freezers

Product verification protocol:	E007/VS01-VP.4
Applies to specification ref(s):	E007/VS01.4
Date of origin:	14 April 2016
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Contents

1. Scope:

This document describes the procedure for verifying the performance of voltage stabilizers suitable for alternating current (ac) powered refrigerators and freezers. A single type is required which is compatible with compression cycle, electric-gas absorption cycle and thermoelectric equipment.

Alternative mains voltage and frequency combinations are also covered. A product that passes the relevant tests will be pre-qualified with a specific type and voltage/frequency designation.

2. Normative references:

Use the most recent version of these standards. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EMAS: *European Union Eco-Management and Audit Scheme.*

IEC 60068-2-6 (2007): *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60335-1:2010+AMD1:2013+AMD2:2016 CSV: *Household and similar electrical appliances - Safety - Part 1: General requirements.*

IEC 61000-6-3 Edition 2.1 (2011): *Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments.*

IEC 61000-6-1 Edition 3 (2016): *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards - Immunity for residential, commercial and light- industrial environments.*

IEC 61000-3-2 Edition 4.0 (2014): *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

ISO 9001 (2015): *Quality Management Systems – Requirements.*

ISO 14001 (2015): *Environmental management systems - Requirements with guidance for use.*

ISO/IEC 17025 (2005): *General requirements for the competence of testing and calibration laboratories.*

ISO 20282-1 (2006): *Ease of operation of everyday products - Part 1: Context of use and user characteristics.*

IEC 60417-5017 (2002): *Graphical symbols for use on equipment – Ground label*

IEC 60947-4-1:2009+AMD1:2012 CSV: *Low-voltage switchgear and control gear-Part 4-1: Electromechanical contactors and motor-starters.*

IEC 60898-1 (2015): *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for A.C. operation*

Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC.

IEC 60085 (2007): *Electrical insulation – Thermal evaluation and designation.*

3. Terms and definitions:

In writing: means communication by letter, fax or email.

Legal Manufacturer: The natural or legal person with responsibility for the design, manufacture, packaging and labelling of a product or device before it is placed on the market under his own name, regardless of whether these operations are carried out by that person himself or on his behalf by a third party.

Reseller: A commercial entity, licensed to act on behalf of a Legal Manufacturer, and

which carries product liability and warranty responsibilities no less onerous than those carried by the Legal Manufacturer.

Under-voltage: An abnormal decrease in the root mean square value of the input voltage from the nominal value for a period longer than half a cycle of the nominal input waveform.

Over-voltage: An abnormal increase in the root mean square value of the input voltage from the nominal value for a period longer than half a cycle of the nominal input waveform.

Electrical withstand: The root mean square value of the maximum input voltage that the device is able to continuously tolerate without any form of electrical or mechanical damage.

Impulsive transient: A sudden, non–power frequency change in the steady-state condition of voltage, current, or both that is unidirectional in polarity – either primarily positive or negative. Often characterized by extremely high voltages that can drive high levels of current into an electrical circuit for periods ranging from a few millionths to a few thousandths of a second.

Overload: A situation where an electrical device is subjected to a greater electrical load than what it was designed for. Results in larger than design electric current passing through conductors, leading to excessive generation of heat, and the risk of fire or damage to equipment

Short circuit: An accidental electrical circuit in a device with no or low resistance when compared to that of the normal circuit, especially one resulting from the unintended contact of components and consequent accidental diversion of current.

4. Applicability:

Type-testing will be carried out by an independent ISO/IEC 17025 testing laboratory approved by WHO PQS.

5. Type-testing procedure:

5.1 Evidence of conformity assessment:

Products must carry the CE mark, UL mark and/or equivalent internationally accepted evidence of conformity assessment.

5.2 Number of samples:

The Legal Manufacturer or Reseller must supply the testing laboratory with a full duplicate set of the Product Dossier already supplied to WHO PQS in accordance with the requirements of specification clause 7. Two samples of the product are required. If the product is available in more than one of the versions and voltage combinations described in specification clause 4.2.2, provide two samples of each version.

5.3 Condition of samples:

The Legal Manufacturer or Reseller must supply all samples to the testing laboratory in the final form to be supplied to the end-customer. In the case of standalone tests of stabilizers meant to be integrated into/unto the body of another product, the stabilizer samples must be supplied to the testing laboratory mounted on a sturdy testing chassis that will mimic as closely as possible the final mounting method and orientation of all stabilizer components in the final product to be supplied to the end customer.

5.4 Test procedure:

5.4.1 Voltage and frequency:

The specific tests listed below apply equally to each combination of stabilizer type and rated input voltage/frequency. Tests need to be conducted in numerical order. Relevant input voltage/frequencies are given in the format: 120/50; 120/60; 230/50 or 230/60. The input supply voltage must be regulated to ±1.0% of the nominal voltage used in the all tests below.

5.4.2 Test 1: Type examination:

- **Step 1:** Check all samples for similarities between different models[1], dissimilarities between samples of one model, and any defects or damage.
- **Step 2:** Record any differences between the samples ordered and those received.
- **Step 3:** Tabulate the following information for each model submitted for examination. Obtain any additional supporting information required in writing from the Legal Manufacturer or Reseller and attach this information to the report:

Identification:
- Code (a unique identifier to be assigned by the testing laboratory);
- Model;
- Legal Manufacturer or Reseller;
- Country of origin;
- Conformity assessment markings (e.g. CE mark).

Performance characteristics:
- Mode of operation conforms/does not conform to specification clause 4.2.1;
- Nominal input and output voltage and frequency options conform/do not conform to specification clause 4.2.2;
- Input voltage regulation range conforms/does not conform to specification clause 4.2.3 (tested as specified in the clause);
- Capacity rating conforms/does not conform to specification clause 4.2.5;
- Tolerance of input frequency fluctuations conforms/does not conform to specification clause 4.2.6 (manufacturer must supply documentary evidence of testing, as specified in the clause);
- Output voltage accuracy conforms/does not conform to specification clause 4.2.7 (tested as specified in the clause);
- Corrosion resistance specification conforms/does not conform to specification clause 4.2.8;
- Electrical safety certification conforms/does not conform to specification clause 4.2.10;
- Electromagnetic compatibility certifications conforms/does not conform to specification clause 4.2.11;

Materials and construction:
- Tabulate all materials in major visible components;
- Note the major rectangular dimensions (±1.0 cm);
- Note the weight (±0.1 kg);
- Insulation materials conforms/does not conform to specification clause 4.2.9;
- Robustness conforms/does not conform to specification clause 4.2.12;

[1] The purpose of this inspection is to establish whether products offered by competing companies are re-badged versions of an otherwise identical device.

- Protection against dust and water ingress conforms/does not conform to specification clause 4.2.13;
- Markings conform/do no conform to specification clause 4.2.14;
- Product environmental capabilities conform/do not conform to specification clauses 4.3.1 and 4.3.2;
- Breadth of product conforms/does not conform to specification clause 4.4.1;
- Weight of product conforms/does not conform to specification clause 4.4.2;
- Power lead conforms/does not conform to specification clause 4.5.2;
- General design of device conforms/does not conform to specification clause 4.6.1;
- Control panel conforms/does not conform to specification clauses 4.6.1 and 4.6.2;
- All materials used in the product conform/do not conform to specification clause 4.7.1.

Warranty

- Warranty conforms/does not conform to specification clause 4.8.

Servicing provision

- Servicing provision conforms/does not conform to specification clause 4.9 (to be self-certified by manufacturer and verified through field performance of the product during deployment in-country).

Disposal and Recycling

- Information materials provided with device conform/do not conform to specification clause 4.10.

Instructions

- Instructions conform/do not conform to specification clause 4.11.

Packaging

- Packaging conforms/does not conform to specifications clause 5.

- **Step 4:** Take a three quarter view digital photograph of each sample. A digital image should be provided for attachment to the PQS report. Take any other photographs needed to illustrate features of the product in the report.
- **Acceptance criteria:** Inspection indicates full conformity with all major specification requirements.

5.4.3 Test 2: Vibration test:

- **Note:** Not applicable for voltage stabilizers meant to be integrated into/unto the body of another product.
- **Number of samples:** 2, in manufacturer's standard packaging.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Securely strap the sample to a vibrating table. Conduct vibration tests following the procedure in IEC 60068-2-6: *Test Fc* as follows:
  - Frequency: 10-150-10 Hz;
  - Amplitude: (mean to peak) 0.35 mm;
  - Rate of change: approximately 1 octave per minute;
  - Acceleration: limited to 2 g (cross-over at 37 Hz);
  - direction: vertical;
  - Endurance: 20 sweep cycles.
- **Step 2:** Unpack the samples and inspect for damage. Check operation of the

stabilizer. Report any damage to the package or to the inside or the outside of the stabilizer. If appropriate, take photographs to illustrate and explain the damage.

- **Acceptance criteria:** There must be no damage to circuit boards or their mountings and the unit must function normally. Light damage to the packaging is acceptable but extensive damage to the packaging is not acceptable – for example if the stabilizer is able to fall out.
- **Rejection criterion:** Failure to meet one or more of the acceptance criteria.

5.4.4 Test 3: Impulsive transient protection test:

- **Number of samples:** 2.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Connect a 120/50; 120/60; 230/50 or 230/60 single-phase, capacitor start induction motor to the output of the voltage stabilizer. The motor must be the nearest size equivalent to the rated capacity of the voltage stabilizer. Connect the output from the motor to a dynamometer so that calibrated loads of 1/5, 1/2 and 1/1 capacity can be obtained. The input to the stabilizer should be variable from 0 volt to the upper limit of the manufacturer specified continuous operating input voltage range.
- **Step 2:** Set the supply input voltage to the minimum voltage within the input voltage regulation range, as specified by the manufacturer, plus 5 volt. Set the inductive load to full rated kVA. Check whether the stabilizer output voltage is within plus (+) 10% maximum and minus (-) 15% of the nominal output voltage.
- **Step 3:** For Sample 1, superimpose one (1) 8kA impulsive transient current impulse with an 8/20μs waveform on the input of the voltage stabilizer. Measure the maximum residual (let through) voltage resulting from this impulsive transient on the output of the voltage stabilizer. (Note – An appropriate sampling rate to accurately characterize this short duration impulsive transient event should be utilized for measurement equipment, where appropriate). Record the maximum residual voltage and measurement sampling rate used.
- **Step 4:** For Sample 2, superimpose fifteen (15) 2kA impulsive transient current impulses with an 8/20μs waveform on the input of the voltage stabilizer. Measure the maximum residual (let through) voltage resulting from this impulsive transient on the output of the voltage stabilizer. (Note – An appropriate sampling rate to accurately characterize this short duration impulsive transient event should be utilized for measurement equipment, where appropriate). Record the maximum residual voltage and measurement sampling rate used.
- **Step 5:** Inspect both units externally and internally for any form of mechanical or electrical component failure, damage or flashover.
- **Acceptance criteria:**
  - No component failures (mechanical or electrical)
  - No component damage or evidence of arc flash between conductors and/or components
  - Applicable to Sample 2 (2kA test) only: Maximum residual (let through) voltage on the voltage stabilizer output is less than 600 volt for 120/50-60Hz devices or less than 1000 volt for 230/50-60Hz devices.
- **Rejection criterion:** Failure to meet one or more of the acceptance criteria.

5.4.5 Test 4: Electrical withstand test:

- **Number of samples:** 2.
- **Test conditions:** +43℃ ±1℃ at Relative Humidity 95%.
- **Step 1:** Setup as in Step 1 of Test 3.
- **Step 2:** Set the inductive load to full rated kVA.

- **Step 3:** Carry out the tests below, with the specified supply input voltage being maintained for 120 minutes for each test. For each test below, note the surface temperature of the hottest surface of the product at the start and end of the test.

Test	Type	Supply Input Voltage
1	120/50-60	40 volt
	230/50--60	100 volt
	230/50—60: Extended	60 volt
2	120/50-60	220 volt
	230/50--60	415 volt
	230/50—60: Extended	415 volt

- **Acceptance criteria:**
  - No component failure or damage (mechanical or electrical)
  - Non-significant increase (less than 5°C) in surface temperatures for the duration of the tests
- **Rejection criterion:** Failure to meet one or more of the acceptance criteria.

5.4.6 Test 5: Voltage regulation range test:

- **Number of samples:** 2.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Setup as in Step 1 of Test 3.
- **Step 2:** Carry out the following tests, with supply voltage being varied from 0 volt to the manufacturer specified upper limit of the continuous operating voltage range in increments of 5 volt, with each voltage step being maintained for 5 minutes:

Test	Variable	Constants	Measurements required
1	Voltage 0-Specified upper limit	Frequency – 50 or 60 Hz as applicable Load - none	Voltage output
2	Voltage 0-Specified upper limit	Frequency – 50 or 60 Hz as applicable Load – 20% of rated kVA	Voltage output
3	Voltage 0-Specified upper limit	Frequency – 50 or 60 Hz as applicable Load – 50% of rated kVA	Voltage output
4	Voltage 0-Specified upper limit	Frequency – 50 or 60 Hz as applicable Load – 100% of rated kVA	Voltage output

- **Step 3:** Collate results in graphical form where appropriate and compare with the stalling characteristics of the test motor.
- **Acceptance criteria:** Voltage regulation range:
  - Input range: Input voltage regulation range as specified by the manufacturer.
  - Output range: 120 volt or 230 volt plus (+) 10% maximum or minus (-) 15% maximum over the full manufacturer specified input voltage regulation range.
- **Rejection criterion:** Failure to control output voltage within the required tolerance over the specified input voltage range.

5.4.7 Test 6: High load starting test:

- **Number of samples:** 2.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Setup as in Step 1 of Test 3.
- **Step 2:** Set the inductive load to full rated kVA.
- **Step 3:** Set the supply voltage to the minimum voltage within the measured input voltage regulation range (see Test 5), plus 5 volt.
- **Step 4:** Cold start the induction motor ten times.
- **Acceptance criterion:** Ten out of ten successful starts.
- **Rejection criterion:** One or more start failures.

5.4.8 Test 7: Endurance test:

- **Number of samples:** 2.
- **Test conditions:** +43℃ ±1℃ at Relative Humidity 95%.
- **Step 1:** Setup as in Step 1 of Test 3.
- **Step 2:** Set the inductive load to full rated kVA.
- **Step 3:** Vary the supply voltage between the minimum in the measured input voltage regulation range (see Test 5), plus 10 volt, and the maximum (see Test 5) minus 10 volt, at a frequency of l0 cycles per minute. The supply input frequency should be 50/60 Hz in accordance with the labelled frequency designation of the device. Continue the test for a minimum of 96 hours. Report any breakdowns.
- **Step 4:** Hold the supply voltage constant at the minimum value within the measured input voltage regulation range (see Test 5). On tap-changing stabilizers, this will be at immediately below the first tap change. Conduct this test for a further 12 hours and report any breakdowns.
- **Step 5:** Hold the supply voltage constant at the maximum value within the measured input voltage regulation range (see Test 5) for a further 12 hours. Report any breakdowns.
- **Step 6:** Set the supply voltage at the nominal value (120 volt or 230 volt), maintain constant, and vary frequency in four steps (as specified below). For each step below, note the surface temperature of the hottest surface of the product at the start and at the instant when frequency is returned to 50-60Hz:
  - Provide frequency of 45Hz for 10 minutes, then return to 50-60Hz for 10 minutes;
  - Provide frequency of 46Hz for 60 minutes, then return to 50-60Hz for 10 minutes;
  - Provide frequency of 64Hz for 60 minutes, then return to 50-60 Hz for 10 minutes;
  - Provide frequency of 65Hz for 10 minutes, then return to 50-60Hz.
- **Acceptance criteria:**
  - No component failures (mechanical or electrical).
  - Non-significant increase (less than 5℃) in surface temperatures during the frequency test (Step 5).
  - The change in the output voltage should be within plus (+) 10% and minus (-) 15% of the nominal output voltage when the input frequency is varied between 45Hz and 65Hz.
- **Rejection criterion:** Failure on any of the acceptance criteria.

5.4.9 Test 8: High/low voltage cut-off test:

- **Number of samples:** 2.
- **Test conditions:** Ambient temperature and humidity.

- **Step 1:** Setup as in Step 1 of Test 3.
- **Step 2:** Set the inductive load to full rated kVA.
- **Step 3:** Vary the supply voltage in 2 volt intervals from 120/230 volt down to zero volt and from 120/230 volt up to the manufacturer specified upper limit of the continuous operating voltage range in order to establish the voltage at which low and high cut-outs occur when connected to the standard inductive load of full rated kVA.
- **Step 4:** Maintain the maximum voltage at which the under-voltage cut-out operates for a period of one minute followed by a period at nominal supply voltage (120/230 volt) until the output voltage is restored. Record the time period between when nominal supply voltage is restored and when output voltage is restored.
- **Step 5:** Maintain the minimum voltage at which the over-voltage cut-out operates for a period of one minute followed by a period at nominal supply voltage (120/230 volt) until the output voltage is restored. Record the time period between when nominal supply voltage is restored and when output voltage is restored.
- **Acceptance criteria:** The over/under-voltage protection cut-out must operate whenever the supply voltage is outside the applicable input voltage regulation range specified by the manufacturer by cutting the output voltage to zero. When the supply voltage is restored to a value within the applicable input voltage regulation range, the output supply of 120/230 volt must be restored automatically after a delay of three to six minutes. Report the cut-out/cut-in voltage thresholds and the cut-in timings.
- **Rejection criteria:** Failure to meet one or more of the acceptance criteria.

5.4.10 Test 9: Overload and short-circuit protection test:

- **Number of samples:** 1.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Connect a 120/50; 120/60; 230/50 or 230/60 single-phase, capacitor start induction motor to the output of the voltage stabilizer. The motor must be the nearest size equivalent to 10 times the rated capacity of the voltage stabilizer. Connect the output from the motor to a dynamometer so that calibrated loads of 1.5, 7.2 and 10 times the rated kVA capacity of the voltage stabilizer can be obtained.
- **Step 2:** Set the supply voltage at the nominal value (110 volt or 230 volt) and frequency (50Hz or 60Hz)
- **Step 3:** Load the voltage stabilizer to 1.5 times the rated capacity of the device and record the time before the output voltage cuts out.
- **Step 4:** Reset the voltage stabilizer and record the time period elapsed between output voltage cut-out and when it is possible to reset the overload disconnect mechanism.
- **Step 5:** Load the stabilizer to 7.2 times the rated capacity of the device and record the time before output voltage cuts out.
- **Step 6:** Reset the voltage stabilizer and record the time period elapsed between output voltage cut-out and when it is possible to reset the overload disconnect mechanism.
- **Step 7:** Load the stabilizer to 10 times the rated capacity of the device and record the time before output voltage cuts out.
- **Acceptance criteria:**
  - The voltage stabilizer output voltage cuts out within 120 seconds when connected to a load equal to 1.5 times the rated capacity.
  - The voltage stabilizer output voltage cuts out within 10 seconds when connected to a

load equal to 7.2 times the rated capacity.
- The voltage stabilizer output voltage cuts out within 100 milliseconds when connected to a load equal to 10 times the rated capacity.
- The voltage stabilizer needs to be manually reset and does not automatically restore output voltage after being connected to an inductive load that exceeds the device's rated capacity by a factor of 1.5 or more.
- A period of 3 to 6 minutes need to elapse before it is possible to reset the overload disconnect mechanism.

- **Rejection criterion:** Failure to meet one or more of the acceptance criteria.

5.4.11 Test 10: IP rating test to IEC 60529:

- **Number of samples:** 1.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Obtain an independent test report from the manufacturer showing full conformity with IEC 60529: IP21 or better. Only if this is not available:
- **Step 2:** Carry out an IP21 test on a single sample.
- **Acceptance criterion:** IP21 test passed.
- **Rejection criterion:** IP21 test failed.

5.5 Test criteria for qualification:

A final report must be issued after all testing is complete. The report of the tests must contain the following data and analyses:

- **Summary:** Conclusions and recommendations.
- **Test 1:** Comments on samples received, tabulated data, compliance with required specifications (plus supporting documentation) and photographs of samples.
- **Test 2:** Results of vibration test.
- **Test 3:** Results of impulsive transient protection test.
- **Test 4:** Results of electrical withstand test.
- **Test 5:** Results of voltage regulation range test.
- **Test 6:** Results of high load starting test.
- **Test 7:** Results of endurance test.
- **Test 8:** Results of high-low voltage cut-off test.
- **Test 9:** Results of overload and short-circuit protection test.
- **Test 10:** Results of IP rating test.
- **Annexes:** A pre-approved test protocol verifying that the procedures set out in this document have been followed. Description of the test apparatus. Test chamber temperature and humidity records. Copies of reference thermometer and humidity measurement calibration certificate(s). Additional supporting documentation requested and received from the Legal Manufacturer or Reseller during the course of the type-testing.

6. Quality control checklist:

6.1 Quality control standards:

All testing and reporting must be carried out in accordance with the requirements of ISO 17025.

6.2 Quality control checklist:

An on-site inspection of the manufacturing plant is not required.

6.3 *Quality control evaluation:*

Not required.

7. Pre-qualification evaluation:

A product will qualify for inclusion on the register of PQS pre-qualified voltage stabilizers in accordance with WHO procedures provided the final report indicates full conformity with the requirements of specification **E007/VS01.4.**

8. Modified products:

The legal manufacturer or reseller must notify WHO in writing of any changes which affect the performance of the product. WHO will carry out a desk evaluation of the reported change(s). If any change is deemed adversely to affect the performance of the product, WHO may request full or partial re- verification based on the test procedures described in this document.

Revision history:

Date	Change summary	Reason for change	Approved
Sept 2017	1. Inclusion of electric-gas absorption cycle and thermoelectric equipment	To cover new technology type recently allowed by PQS	IG
	5.4.2 Inclusion of check for continuous operating input voltage range	Specification check missing in previous revision	IG
	5.4.4 Inclusion of impulsive transient protection test	To test protection against impulsive transients such as lightning	IG
	5.4.5 Inclusion of electric withstand test	To test equipment for continuous performance under sustained under/overvoltage	IG
	5.4.8 Removal of 230/450V spike test	These test conditions are now better covered by clause 5.4.2	IG
	5.4.8 Modified ambient temperature from 45°C to 43°C	To be in line with maximum ambient operating temperatures required for refrigerators/freezers	IG
	5.4.8 Modified output voltage accuracy to +10% and -15%	To be in line with accuracy requirements in rest of document	IG
	5.4.10 Inclusion of overload protection test	To test protection of device against overload conditions	IG
	5.4.2–5.4.11 Reordered and tests are now required to follow in numerical order	In order to present a more logical flow of performance tests	IG
	Throughout document – Various minor changes to verbiage	To more concisely reflect requirements of test protocol	IG
Oct 2016	4. Removed requirement for testing laboratory to be accredited by WHO	ISO certified laboratory sufficient	IG
	5.3 Additional paragraph to specify condition of test sample provided to test laboratory.	Included to cover integrated stabilizer tests	IG

	5.4.3 Upper voltage limit of test updated to reflect manufacturer specified operating limit	Included to better reflect the minimum protection standard tested by this document	IG
	5.4.3 Output tolerance updated to reflect performance over full specified operating range	Included to better reflect the minimum protection standard tested by this document	IG
	5.4.5 Step 2 updated to reflect the lower limit of manufacturer specified voltage range	Included to better reflect the minimum protection standard tested by this document	IG
	5.4.5 Nomenclature of Step 3 updated to test endurance at upper limit of operating range	Included to better reflect the minimum protection standard tested by this document	IG
	5.4.5 Specification of spike test in Step 4 updated. Updated requirement during spike test	Included to better reflect the minimum protection standard tested by this document	IG
	5.4.5 Updated frequency band specification in Acceptance Criteria		IG
	5.4.6 Included Step 3 to test voltage recovery after over-voltage protection cut-off	Included to better reflect the minimum protection standard tested by this document	IG
	5.4.6 Updated Acceptance Criteria nomenclature to refer to manufacturer operating range	Included to better reflect the minimum protection standard tested by this document	IG
Dec 2015	Modification of the working in test 2 step 2 to include the incremental change in voltage	Feedback from manufacturers	IG
	Inclusion of the effect on voltage of changes in frequency	Feedback from manufacturers	IG