PQS Independent type-testing protocol

TITLE: Voltage stabilizer for mains electric refrigerators and freezers

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1. Scope:

This document describes the procedure for verifying the performance of voltage stabilizers suitable for mains electric refrigerators and freezers. A single type is required which is compatible with both compression cycle and absorption cycle refrigerators.

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:

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 60038: *IEC standard voltages.*

IEC 60068-2-6: *Environmental testing – Part 2-6: Tests – Test Fc: Vibration*

(sinusoidal)
IEC 60335-1: *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 2 (2005): *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)*
IEC 61643-11: *Low-voltage surge protective devices – Part 11: Surge protective devices.*
ISO 9001: *Quality Management Systems – Requirements*.
ISO 14001: *Environmental management systems - Requirements with guidance for use.*
ISO/IEC 17025: *General requirements for the competence of testing and calibration laboratories.*
ISO 20282-1: *Ease of operation of everyday products - Part 1: Context of use and user characteristics.*
Directive 2004/108/EC of the European Parliament and of the Council.

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.

4. Applicability:

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

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 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 *Test procedure:*

5.3.1 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;
  - Protection voltage range conforms/does not conform to specification clause 4.2.4 (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 4.2.9;
  - Electromagnetic compatibility certifications conforms/does not conform to specification clause 4.2.10;
  - Markings conform/do not conform to specification clause 4.2.13;

  Materials and construction:
  - Tabulate all materials in major visible components;
  - Note the major rectangular dimensions (±1.0 cm);
  - Note the weight (±0.1 kg);
  - Robustness conforms/does not conform to specification clause 4.2.11;
  - Protection against dust and water ingress conforms/does not conform to specification clause 4.2.12;
  - Product environmental capabilities conform/do not conform to specification clause 4.3;
  - Breadth of product conforms/does not conform to specification clause 4.4.1;
  - Power lead conforms/does not conform to specification clause 4.5.2;
  - Control panel conforms/does not conform to specification clause 4.6.2;

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

- 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).

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 JPEG 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.

5.3.2 Voltage and frequency

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

5.3.3 Test 2: Voltage regulation range

- **Number of samples:** 2.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Connect a 120/50; 120/60; 230/50; 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 1/2 and 1/1 capacity can be obtained. The input to the control unit should be variable from 0 to 159/300 volts AC.
- **Step 2:** Carry out the following tests, with voltage being varied from 0-159/300V in increments of 5V, with each voltage step being maintained for 5 minutes.

Test	Variable	Constants	Measurements required
1	Voltage 0-159/300 V AC	Frequency – 50 or 60 Hz as applicable Load - none	Voltage output
2	Voltage 0-159/300 V AC	Frequency – 50 or 60 Hz as applicable Load – 20% of rated kVA	Voltage output
3	Voltage 0-159/300 V AC	Frequency – 50 or 60 Hz as applicable Load – 50% of rated kVA	Voltage output
4	Voltage 0-159/300 V AC	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:** Operating voltage range:
  - Input range: Minimum nominal input voltage -25.0% or maximum nominal input voltage +25.0% in accordance with the table in specification clause 4.2.3.

- Output range: 120 volts/230 volts ± 7.0% or better.

- **Rejection criteria:** Failure to control output voltage within the required tolerance over the specified input voltage range.

5.3.4 Test 3: High load starting:

- **Number of samples:** 2.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Set the input voltage under full load condition to the minimum in the operating range (see Test 2) plus 5.0 volts.
- **Step 2:** Cold start a single phase, capacitor start induction motor of rated capacity ten times.
- **Acceptance criterion:** Ten out of ten successful starts.
- **Rejection criterion:** One or more start failures.

5.3.5 Test 4: Endurance test:

- **Number of samples:** 2.
- **Test conditions:** +45°C ±1°C at RH 95%.
- **Step 1:** Connect each unit to the inductive load of full rated kVA and vary the input voltage between the minimum in the operating range (see Test 1), plus 10.0 volts, and the maximum (see Test 1) minus 10.0 volts, at a frequency of l0 cycles per minute. The mains 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 2:** Continue the Step 1 test for a further 12 hours holding the supply voltage constant at the lower end of the operating voltage range (on tap-change stabilizers, immediately below the first tap change). Report any breakdowns.
- **Step 3:** Continue the Step 1 test for further 12 hours with the input voltage held at 159/300 volts. Report any breakdowns.
- **Step 4:** Apply a 230/450 volt spike to the input supply under the same load conditions. Check whether the cut-out and auto-reset operates normally without damage to the stabilizer components.
- **Step 5:** Set voltage at recommended value (110V or 230V), 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
  - No cut off should occur in the spike test (Step 4)
  - Significant increase (greater than 5C) in surface temperatures during the frequency test (Step 5).
  - The change in the output voltage should be within +/-20% of the nominal output voltage when the input frequency is varied between 50Hz and 70Hz
- **Rejection criterion:** Failure on any of the acceptance criteria.

5.3.6 Test 5: High/low voltage cut-off test:

- **Number of samples:** 2.
- **Test conditions:** Ambient temperature and humidity.
- **Step 1:** Vary the input voltage in 2.0 volt intervals from 120/230 volts down to zero volts and from 120/230 volts up to 170/320 volts 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 2:** Maintain the voltage at which the cut-out operates for a period of one minute followed by a recorded period at 120/230 V until the output voltage is restored.
- **Step 3:** Apply a 230/450 volt spike to the input supply with the same load conditions. Check whether the cut-out and auto-reset operates normally without damage to the stabilizer components.
- **Acceptance criteria:** The over/under-voltage protection cut-out must operate whenever the input voltage is outside the applicable range shown in the table in specification clause 4.2.3 by cutting the output voltage to zero. When the input voltage is restored to a value within the applicable range, the output supply of 120/230 volts 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.

5.3.7 Test 6: Vibration test:

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

5.3.8 Test 7: 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. Record results.
- **Acceptance criterion:** IP21 test passed.
- **Rejection criterion:** IP21 test failed.

5.4 *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 and photographs of samples.
- **Test 2:** Results of voltage regulation range test.
- **Test 3:** Results of high load starting test.
- **Test 4:** Results of endurance test.
- **Test 5:** Results of high low voltage cut-off test.
- **Test 6:** Results of vibration test.
- **Test 7:** 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/VS01.2.**

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
Dec 2015	Modification of the working in test 2 step 2 to include the incremental change in voltage	Feedback from manufacturers	IG
Dec 2015	Inclusion of the effect on voltage of changes in frequency	Feedback from manufacturers	IG