IECEE CTL	**CTL OPERATIONAL PROCEDURE**	**CTL-OP 110**

Procedure for Measuring Laboratory Power Source Characteristics

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1.0 PURPOSE

1.1 The purpose of this document is to establish a procedure for measuring laboratory power source characteristics to determine conformance with the default characteristic requirements for laboratory power sources established by the IECEE CB Scheme.

1.2 The results of many tests on electrical products tested in accordance with product safety testing standards depends of the characteristics of electrical power source used to power the product under test. Some examples of how power source characteristics can affect test results are:

A. Temperatures on electrical heat generating parts are affected by the voltage applied. In most cases an increase in voltage causes an increase in temperature. While, for some products, a decrease in voltage also results in an increase in temperature.

B. The frequency of the power source can also affect temperatures on electrical heat generating parts such as motors, transformers and solenoids

C. The harmonic distortion of a power source not only affects temperature of electrical heat generating parts such as motors, transformers and solenoids, but also affect leakage currents for the product.

1.3 Accordingly, testing standards specify the voltage, frequency and wave shape of the power source to be used - for example 230 volt, 50 Hertz, sinusoidal power source. These specifications in the standard are made with the understanding that the specified characteristics are maintained as stated throughout the testing done. In the real world, however, a power source that meets these ideal specifications is not possible. Some standards recognize this and include tolerances for the power source specifications. While, other standards do not. The CTL has proposed default power source stability requirements to be followed when the test standard does not contain tolerances for the power source to be used. These power source stability requirements define the characteristics of real world power sources that can be used in the testing laboratory, so that laboratories can obtain consistent, uniform and repeatable results and, thus, further the exchange of testing data among members of the CB Scheme.

2.0 SCOPE

2.1 The procedure described in this document applies to measurement of laboratory power source voltage and frequency stability, and total harmonic distortion (THD) to determine conformance with the default characteristic requirements for laboratory power sources established by the IECEE CB Scheme.

2.2 This guide applies to the following situations:

- Testing is performed within the maximum rated current/load capacity of the power source.
- Normal operating conditions of the tested product.

2.3 The requirements apply to stability of laboratory power sources only. The requirements do not address short circuit current testing, abnormal testing, switching testing and the like that relate to source capacity.

2.4 The power source stability requirements apply to testing of products that are connected to ordinary branch circuits found in residences and businesses - for example 120 V, 15 and 20 A; 240 V, 15 A circuits in North America and 230 V, 10 and 15 A branch circuits in Europe.

3.0 DEFINITIONS

3.1 Definitions unique to this document

A. Automatic adjustment (power source) – Regulation of power source by electronic, electrical or mechanical means that automatically maintains the voltage and/or frequency at a prescribed value.

B. Manual adjustment (power source) – Regulation of power source by manual adjustment of an autotransformer, tapped transformer with selector switch or similar means to maintain the voltage and/or frequency at a prescribed value.

C. Robust power source – Power source of sufficient capacity to meet the power source stability requirements without the need for further regulation or adjustment.

3.2 Acronyms unique to this document

A. Maximum open circuit voltage, $V_{oc,max}$

B. Minimum open circuit voltage, $V_{oc,min}$

C. Maximum voltage loaded, $V_{ld,max}$

D. Minimum voltage loaded, $V_{ld,min}$

E. Current loaded, I_{ld}

F. Voltage nominal, V_{nom} = specified test voltage (e.g. 120 V, 230 V, 240 V)

G. Maximum frequency open circuit, $F_{oc,max}$

H. Minimum frequency open circuit, $F_{oc,min}$

I. Maximum frequency loaded, $F_{ld,max}$

J. Minimum frequency loaded, $F_{ld, min}$

K. Maximum harmonic distortion open circuit, THD_{oc}

L. Maximum harmonic distortion loaded, THD_{ld}

3.3 Equations unique to this document

A. Voltage regulation open circuit:
Reg V_{oc} = [MAX($V_{oc,max}$ -V_{nom}; V_{nom} - $V_{oc, min}$)/V_{nom}] x 100%

B. Voltage regulation loaded:
Reg V_{ld} = [MAX($V_{ld,max}$ -V_{nom}; V_{nom} - $V_{ld, min}$)/V_{nom}] x 100%

C. Frequency regulation open circuit:
Reg F_{oc} = [MAX($F_{oc,max}$ -F_{nom}; F_{nom} - $F_{oc, min}$)/F_{nom}] x 100%

D. Frequency regulation loaded:
Reg F_{ld} = [MAX($F_{ld,max}$ -F_{nom}; F_{nom}- F_{ld}, min)/F_{nom}] x 100%

E. Total Harmonic Distortion:
THD = SQRT(sum of all squares of amplitude of all harmonic voltages/square of the amplitude of the fundamental voltage) x 100%

Note: Function **MAX(value 1; value 2)** returns the maximum of **value 1** and **value 2**.
Example: In the calculation MAX(V_{max}-V_{nom}; V_{nom}-V_{min}) use the maximum value of either upper (V_{max}-V_{nom}) or the lower (V_{nom}-V_{min}).”

4.0 RESPONSIBILITY OF THE LABORATORY

4.1 Laboratory power source characteristics suitability measurements shall be performed upon initial installation, modification and repair of the laboratory power source(s).

4.2 Test voltages shall be monitored for stability throughout the performance of testing programs to ensure conformance with the voltage stability requirements.

4.3 In accordance with ISO/IEC 17025:2005 clause 5.3.2, it is the responsibility of the laboratory to monitor, control and record characteristics of the laboratory power source to ensure continued conformance with the requirements. Considerations to be taken into account include changes in characteristics of the power as supplied by the electric utility (or other source), changes in load conditions on the power source substation due to power consumption of neighboring businesses and affects of other testing being conducted in the laboratory.

5.0 APPLICABLE DOCUMENTS

Doc. #	Title
ISO/IEC 17025, 2nd ed., 2005-05-15	General requirements for the competence of testing and calibration laboratories.

6.0 GENERAL

Instructions given in this document are to be followed to assure test consistency and repeatability.

7.0 EQUIPMENT

7.1 Instruments:

7.1.1 Voltmeter
7.1.2 Ammeter
7.1.3 Frequency meter
7.1.4 Total harmonic distortion analyzer
7.1.5 Resistive loads

Note 1 – Other types of equipment providing equivalent functionality may be used.

Note 2 – Accuracy of meters shall conform with CTL DSH-251a.

8.0 REQUIREMENTS

8.1 When not otherwise specified in the testing standard, the power source used for testing shall meet the following requirements:

A. Voltage stability: +/- 3 percent maximum

B. Frequency stability: +/- 2 percent maximum

C. Total harmonic distortion (THD): maximum 5 percent

8.2 Conditions are to be maintained at the point of testing.

8.3 Voltage regulation may be achieved by:

A. Robust source – acceptable for all situations.

B. Automatic Adjustment – Acceptable for all normal operating conditions. May be used for abnormal conditions if regulator is sufficiently robust and fast acting to handle demands under fault conditions.

C. Manual adjustment –such as auto-transformer in conjunction with periodic voltage monitoring (for example every 15 minutes minimum) if load is constant. Cannot be used for fluctuating loads and abnormal tests.

9.0 PROCEDURES

9.1 Method for Single Phase Power Source

9.1.1 Characteristics of electrical power sources representing electrical mains connections used in the testing laboratory shall be measured at the point where tests are performed. Typically, this point is considered to be test station receptacle or wiring terminals where the test setup is connected.

9.1.2 Power source voltage, frequency and harmonic distortion shall be measured.

9.1.3 While it is expected that the power source meet the required specifications throughout the duration of any testing performed, measurement of power source characteristics is normally made over a one hour period in each the open circuit and loaded conditions, unless there is reason to believe that measurements made over a longer period is necessary to establish conformance with the intent of the requirements.

9.1.4 Initially, the voltage, frequency (50 or 60 Hz) `and harmonic distortion of the power source shall be measured open circuit over a period of one hour. The voltage shall be adjusted to one of the nominal voltages used for testing, for example 120 V, 230 V, 240 V or 400 V.

9.1.5 Afterwards the power source shall be loaded to rated maximum normal resistive load (continuous duty) for a period of one hour without readjustment of the power source during which time the voltage, frequency and harmonic distortion shall be measured. The power source shall comply with the requirements throughout the duration of the test.

9.2 Values to be recorded/calculated

9.2.1 Maximum open circuit voltage, $V_{oc,max}$

9.2.2 Minimum open circuit voltage, $V_{oc,min}$

9.2.3 Maximum voltage loaded, $V_{ld,max}$

9.2.4 Minimum voltage, $V_{ld,\ min}$

9.2.5 Current loaded, $I_{ld,\ max}$

9.2.6 Voltage nominal, V nom = specified test voltage (e.g. 120 V, 230 V, 240 V)

9.2.7 Maximum frequency open circuit, $F_{oc,max}$

9.2.8 Minimum frequency open circuit, $F_{oc,min}$

9.2.9 Maximum frequency loaded, $F_{ld,max}$

9.2.10 Minimum frequency loaded, $F_{ld,\ min}$

9.2.11 Maximum harmonic distortion open circuit, THD_{oc}

9.2.12 Maximum harmonic distortion loaded, THD_{ld}

10.0 RECORDS

10.1 Records shall be made and retained of measurements made, calculated values, location of measurements and conditions of measurements in accordance with the responsibility noted in clause 4.1.3 and required laboratory practice under ISO/IEC 17025. Annex 1 (informative) contains a suggested format for recording the data.

10.2 Records of the power distribution system shall include wiring diagrams, identification of voltages, frequencies, number of phases, capacities, fuse/circuit breaker ratings and regulation equipment.

ANNEX 1

(Informative)

Date: Tested by (name/signature):

Power Source Stability Test:

Method

Power source stability characteristics were measured in accordance with CTL-OP 110.

Results

Location and characteristics: _____

Measured Quantity	Value
Voltage nominal, V nom =	
Maximum open circuit voltage, $V_{oc,max}$ =	
Minimum open circuit voltage, $V_{oc,min}$ =	
Current loaded, $I_{ld,\ max}$ =	
Maximum voltage loaded, $V_{ld,max}$ =	
Minimum voltage, $V_{ld,\ min}$ =	
Maximum frequency open circuit, $F_{oc,max}$ =	
Minimum frequency open circuit, $F_{oc,min}$ =	
Maximum frequency loaded, $F_{ld,max}$ =	
Minimum frequency loaded, $F_{ld,\ min}$ =	
Maximum harmonic distortion open circuit, THD_{oc} =	
Maximum harmonic distortion loaded, THD_{ld} =	
Reg V_{oc} = [MAX($V_{oc,max}$ - V_{nom}; V_{nom} - $V_{oc,\ min}$)/V_{nom}] x 100% =	
Reg V_{ld} = [MAX($V_{ld,max}$ - V_{nom}; V_{nom} - $V_{ld,\ min}$)/V_{nom}] x 100% =	
Reg F_{oc} = [MAX($F_{oc,max}$ - F_{nom}; F_{nom} - $F_{oc,\ min}$)/F_{nom}] x 100% =	
Reg F_{ld} = [MAX($F_{ld,max}$ - F_{nom}; F_{nom} - F_{ld}, min)/F_{nom}] x 100% =	

Test Equipment Used

Name	Manufacturer	Model	Range	Last Calibration	Next Calibration
Voltmeter					
Ammeter					
Frequency meter					
THD Analyzer					
Load				N/A	N/A