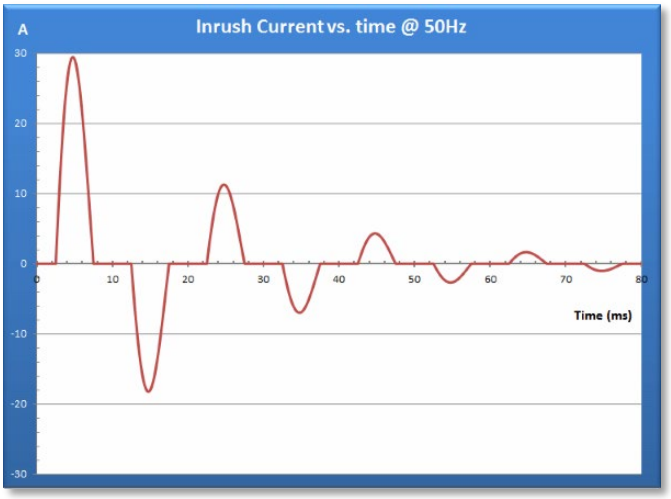
IEC 61000-4-11 & 34 Testing and AC Source Peak Current



RELEVANT IEC STANDARDS

- IEC61000-4-11
- IEC61000-4-34

AC VOLTAGE DIPS

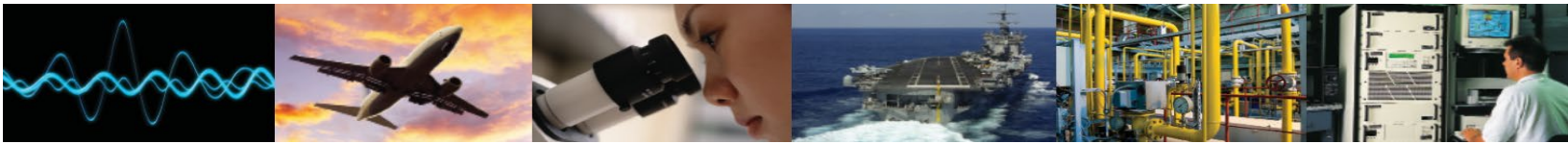
1 Preface

This application note reviews the AC source generator peak current rating requirements as covered by section 6.1.2, Table 4 of IEC test standard IEC61000-4-11 and section 6.1.1, Table 4 of IEC61000-4-34. Also included is a review of Appendix D, section D.6 that addresses this requirement in more detail and provides a rationalization for it. This requirement is often misunderstood. Note that quoted sections of the actual IEC standards are highlighted using blue fonts in this application note.

2 Relevance

Before reviewing the actual peak current support requirement of the AC power source used for voltage dips and interruptions testing, it is important to understand that for many product categories that require testing to IEC61000-4-11 or IEC61000-4-34, the phase angles called out for the **actual** tests are typically only 0° and 180°. While the generic -4-11 and -4-34 standards define other possible voltage interruption or dip phase angles like 90° and 270°, the actual test requirement for any given product are determined by their relevant IEC product category standard. This product standard in turn refers to the generic -4-11 and -4-34 standards for reference but dictates the actual test levels and test phase angles to be used. At this time there are only a couple medical products that require testing for dips at 90 and 270 degrees.

Since at 0° and 180° phase angles the AC sine wave is at zero volts, inrush current will be far less than at 90° or 270° so the requirement for the AC Source to support 500Apk or 1000Apk is often irrelevant. Thus, for test labs where the category of products that will be tested is known in advance, provisions to ensure the AC source used meets these high peak current requirements may not be relevant and can result in significant cost savings.



3 Pertinent Sections of both IEC Standards

This section contains the relevant sections of the IEC61000-4-11 (EUT's up to 16A/phase) and IEC61000-4-34 (EUT's > 16A/phase).

3.1 IEC61000-4-11 Section 6.1.2, Table 4, Text:

The relevant row of Table 4 states the following:

Output current capability (no requirement for voltage variation tests)	16 A RMS per phase at rated voltage. The generator shall be capable of carrying 20 A at 80 % of rated value for a duration of 5 s. It shall be capable of carrying 23 A at 70 % of rated voltage and 40 A at 40 % of rated voltage for a duration of 3 sec. (This requirement may be reduced according to the EUT's rated steady-state supply current, see Clause A.3.)
Peak inrush current capability (no requirement for voltage variation tests)	Not to be limited by the generator. However, the maximum peak capability of the generator need not exceed 1 000 A for 250 V to 600 V mains, 500 A for 200 V to 240 V mains, or 250 A for 100 V to 120 V mains.

Rationalization Annex D Text:

D.6 Rationale for inrush current capability

During the connection of an equipment to a power line, an inrush current flows into it. This inrush current could conceivably damage parts of the equipment, for example an input rectifier with capacitive smoothing. In order to prevent damage, measures for inrush current limitation are usually incorporated inside the equipment.

An inrush current will also occur when the line voltage recovers after a voltage dip or interruption. In this case, the inrush current limitation measures might not be activated in the equipment with disabled pre-charge circuit, so it is possible for the post-dip inrush current to damage the equipment.

For this reason, it is necessary for the voltage dip generator to be capable of supplying sufficient current and that the post-dip inrush current is not limited by the dip generator.

Without this inrush current requirement, it would be possible for the equipment to pass the immunity test performed with the dip generator, but to fail in the real world due to inrush current damage.

In a real installation, this inrush current will be limited by the network impedance. If the short circuit is on the public supply, the network impedance is according to the line reference impedance of the public supply (796 µH according to IEC TR 60725), which is typical for rural low voltage networks, and it will limit the inrush current to about 15 A to 20 A. However, if the short circuit is inside the local premise, in a particular large installation such as an industrial plant, the impedance can be much lower and the inrush current much larger.

In order for the test generator to have adequate capabilities to properly stress the equipment under test, the document provides guidance in 6.1.3 to ensure that the equipment does not demand more current than 70 % of the generator capability, for example 500 A for 220 V to 240 V mains.

3.2 IEC61000-4-34 Section 6.1.1, Table 4, Text:

The relevant row of Table 4 states the following:

Peak inrush current capability (no requirement for voltage variation tests)	See Annex A

Annex A, Section A.1 Test generator inrush current requirement

The test generator shall be capable of supplying the peak inrush current shown in Table A.1.

Rated current of Equipment	Minimum peak inrush current capability of the generator
16 A – 50 A	500 A
50,1 A – 100 A	1000 A
More than 100 A	Not less than 1000 A, and sufficient to maintain ±10 % of required voltage value during maximum peak inrush, measured as rms. value refreshed each ½ cycle per IEC 61000-4-30.

4 Inrush Current when using EPTS Test Option

For Pacific Power Source ECTS2 Harmonics and Flicker test systems equipped with the Electronic Power Transfer Switch (EPTS) option, the relevance of peak current capability is determined by the test setup used.

- **AC Grid + AC Source Setup:** If the nominal AC test voltage is provided by the local utility grid power – which is the most common test setup - the programmable AC source's inrush current rating is not relevant as any peak inrush current drawn by the unit under test after each voltage dip or interruption is provided by the AC power grid and not the programmable AC power source used to provide the required voltage dips and interruption levels. Thus, the sections of both IEC standards referenced before are irrelevant. This setup is illustrated in Figure 1 below.

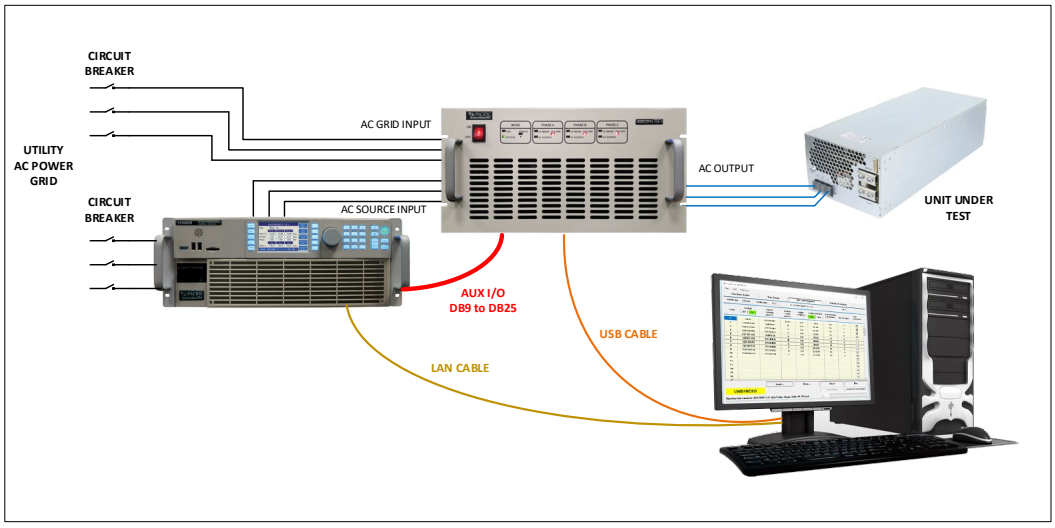


Figure 1: Standard EPTS Test Setup

- **Dual AC Source Setup:** If on the other hand a second AC power source is used to provide the nominal test voltage and frequency in place of the local AC power grid, these sections are relevant. In that case, refer to the next section for more. This setup is illustrated in Figure 2 below.

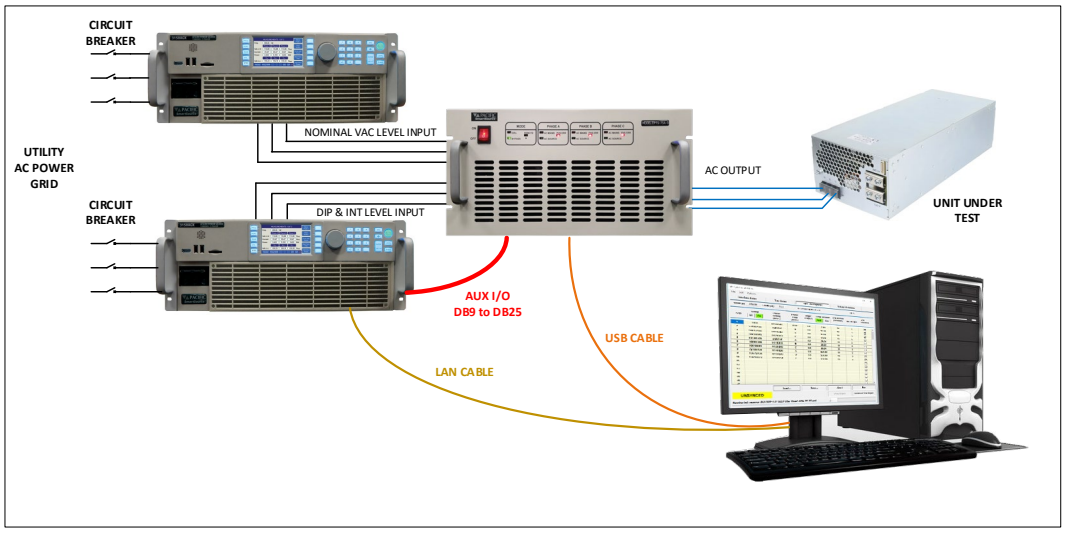


Figure 2: Dual AC Source EPTS— Test Setup

5 Inrush Current when using a programmable AC power source

When the AC source is used to provide both the nominal test voltage and the voltage dip and interruption levels, it must have sufficient peak current capability to meet the peak current levels required per the test standard.

The most relevant requirement for IEC61000-4-11 applications is the 500 Apk for 200 V to 240 V mains as most CE marked products intended for use in Europe will be connected to 230Vac grid voltages. For ECTS2 test systems based on AFX Series power sources that do NOT have the EPTS option, the following peak currents are supported by the AFX power source models shown. For EUT's with peak inrush currents up to 1000A, these values must be double of those shown here.

AFX Model	Peak Current 1 Phs Mode	70% of Rating Value	Peak Current 3 Phs per Phs	70% of Rating Value
360AFX	312 Apk	218 Apk	104 Apk	73 Apk
3150AFX	312 Apk	218 Apk	104 Apk	73 Apk
3300AFX	624 Apk	436 Apk	208 Apk	146 Apk
3450AFX	936 Apk	655 Apk	312 Apk	218 Apk
3600AFX	1248 Apk	874 Apk	416 Apk	291 Apk
3900AFX	2808 Apk	1966 Apk	624 Apk	437 Apk

Table 1: AFX Search Peak Current Ratings 100% and 70% Levels

5.1 Determining AC Power Source Inrush Current Capability

To verify the AC power source's peak inrush capability, the test procedure called out in Annex A of the IEC61000-4-11 standard may be used. The setup is shown below. The capacitor value is 1700uF. The bleeder resistor R is between 100 and 10,000 Ohms. Voltage turn-on angles used are 90° and 270° to capture both positive and negative peak current levels after both 5 mins and 5 secs of off time.

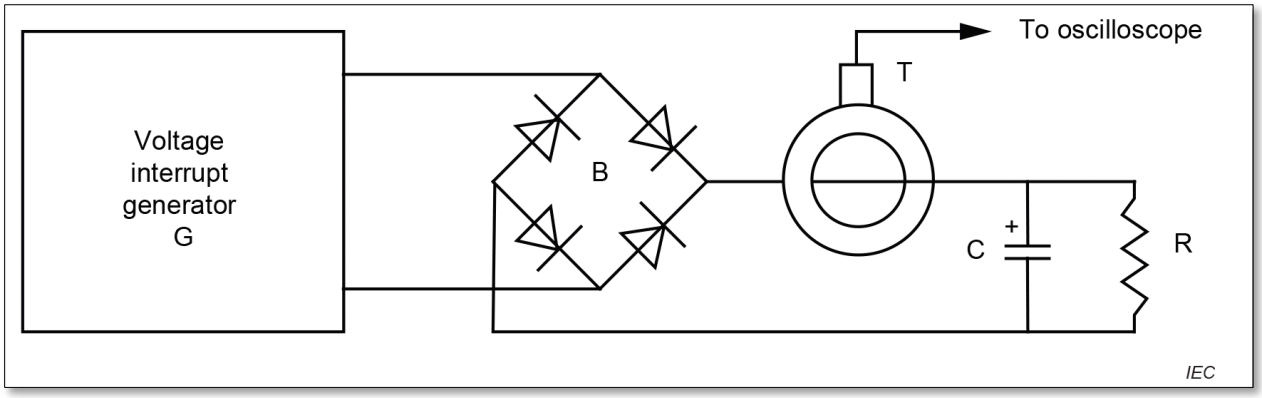


Figure 3: Test Setup to verify AC Power Source Peak Inrush capability

If the inrush current of the EUT is **less than 70%** of the rating of the test generator, the test generator (AC Source) can be used to perform all tests. The inrush requirement of the EUT can be determined using the same test procedure with the actual EUT connected to the power source instead of the Bridge rectifier / capacitor / resistor test load and using the AFX Series peak current max hold measurement function, so no CT and scope are needed.

Note: This verification is needed only for EUTs categories whose IEC product standard calls out voltage interruptions to 90° and/or 270°. At this time there are only a few medical electrical products that require testing at 90 and 270 degrees. Details are provided in the family of IEC 60601-1-x standards. Refer to section 2, "Relevance".

6 Summary

For most product categories that are tested using voltage interruptions at 0° and 180°, the inrush current requirement of the AC power source is not an important consideration. For those product categories that have to be tested using 90° and/or 270° phase angles voltage interruptions, the AC power source may have to be oversized to meet the required peak current capability.

If however, the Pacific's Electronic Power Transfer Switch (EPTS) is used for IEC 61000-4-11 and IEC 61000-4-34 testing, the EUT peak inrush current is provided by the AC mains. This approach is particularly useful in Asia and Europe. EPTS units are available in single or three phase version and up to 100Arms per phase. See https://pacificpower.com/products/ects2-series/#products-ects2-models for available models.

For USA applications, a second AC source or AC Generator is needed to test with 50Hz, 230V_{LN} single or three phase nominal voltage. In this case, the second AC source should be sized to support EUT peak inrush current as covered in section 5.

Note that the EPTS is also required to meet the 1 to 5 µsec rise and fall time requirement per IEC 61000-4-11 Ed.3. For many actual product testing applications, the AFX Series AC power source by itself can suffice, certainly for pre-compliance, and the user can the EPTS option to an ECTS2 harmonics and flicker system at a later time in the event that full compliance with the 1to 5 µsec rise/fall is required.

For more information on this, see separate Application note "IEC 61000-4-11 & 34 Testing and AC Source Rise & Fall Time"

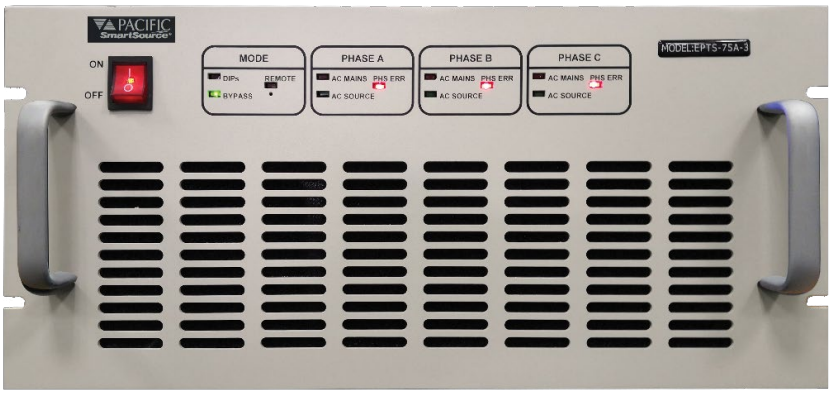


Table 2: EPTS Series Electronic Power Transfer Switch

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