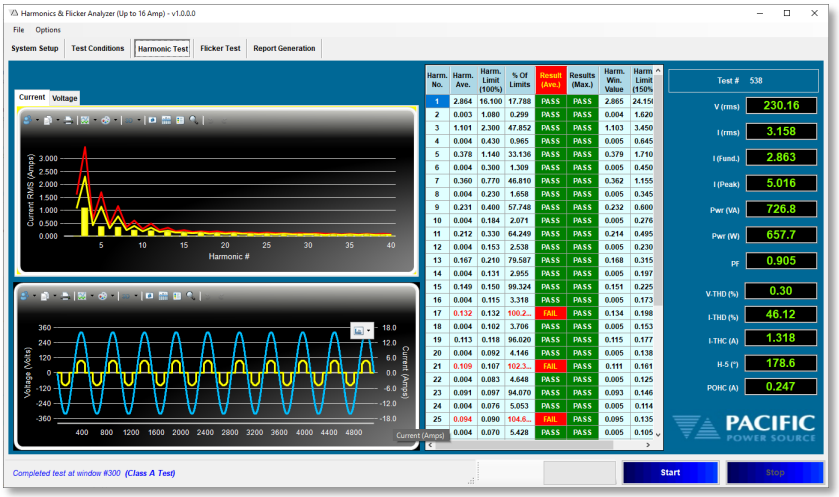
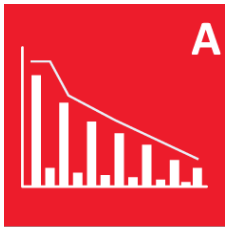
EN/IEC 61000-4-7 Harmonic Measurement Accuracy



RELEVANT IEC STANDARDS

- IEC 61000-4-7
- IEC 61000-3-2
- IEC 61000-3-12



HARMONICS

1 Preface

This application note discusses the impact of the stated voltage and current measurement accuracies in the IEC61000-4-7 Harmonics Measurements Reference Document:

> *EC 61000-4-7:2002+AMD1:2008 CSV, Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation. Edition 2.1*

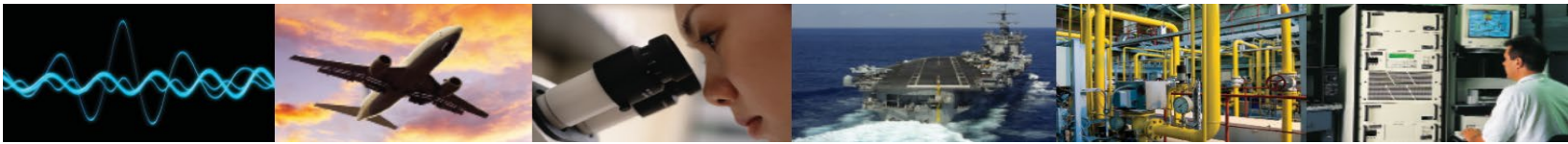
This reference standard describes the required implementation of harmonics and interharmonics measurement systems. This standard is referenced in both the EN/IEC61000-3-2 and the EN/IEC61000-3-12 Harmonics Emissions Test Standards.

For those considering acquiring new Harmonics and Flicker test equipment or upgrading their existing systems, the information in this application note may be of value in making the best possible equipment selection or asking the right questions of their equipment vendors to ensure the correct applicable IEC Standard Editions are supported.

2 Relevance

The current published Edition of the IEC61000-4-7 Harmonics standard is version 2.1 and was published in 2009. It is intended to allow consistent measurement to determine product compliance to EU standard to be made across different test labs using different test labs with sufficient accuracy.

Accuracy is especially important for higher order harmonics as they are at higher frequencies – multiples of 50 or 60 Hz up to 40 Harmonics so 2000 Hz or 2400 Hz – and because higher order voltage and current harmonics tend to be much smaller than the fundamental values. Thus, the fundamental current may be at 12 Arms but the 39th harmonic may only be 40 mA and the IEC61000-4-2 limit for the 39th current harmonic is only 57.7 mA. Thus, current measurement accuracy – or the lack thereof – has a much greater impact for harmonics measurements than it does for RMS measurements.



3 IEC61000-4-7 Standard Accuracy Requirements for Measurements

The required voltage, current and power measurement required for harmonics emissions measurements are defined by Table 1 of the IEC61000-4-7 Reference standard. The IEC61000-3-2 and IEC61000-3-12 Harmonics Emissions standard allow both Class I or Class II accuracy measurements but Class II only under specific conditions as long as it is clear that the limits are not exceeded. In practice this means the measured harmonics values must all be less than 90% of the permissible limits.

The table is shown below for reference. Note that there is distinction made for large versus small signal measurements. Small signal is defined as signals less than 1% of Unom for voltage and less than 3% of Inom for current. For power, an absolute small signal level of less than 1.5 Watt applies.

Note that accuracies for large signals are specified in percent of measured value and those for small signals in percent of nominal value. This can be confusing when comparing measurement accuracy specifications between different Harmonics and Flicker test systems.

Class	Measurement	Conditions	Maximum error
I	Voltage	$U_m \geq 1\%\ U_{nom}$ $U_m < 1\%\ U_{nom}$	$\pm 5\%\ U_m$ $\pm 0{,}05\%\ U_{nom}$
	Current	$I_m \geq 3\%\ I_{nom}$ $I_m < 3\%\ I_{nom}$	$\pm 5\%\ I_m$ $\pm 0{,}15\%\ I_{nom}$
	Power	$P_m \geq 150$ W $P_m < 150$ W	$\pm 1\%\ P_m$ $\pm 1{,}5$ W
II	Voltage	$U_m \geq 3\%\ U_{nom}$ $U_m < 3\%\ U_{nom}$	$\pm 5\%\ U_m$ $\pm 0{,}15\%\ U_{nom}$
	Current	$I_m \geq 10\%\ I_{nom}$ $I_m < 10\%\ I_{nom}$	$\pm 5\%\ I_m$ $\pm 0{,}5\%\ I_{nom}$
I_{nom}: Nominal current range of the measurement instrument U_{nom}: Nominal voltage range of the measurement instrument U_m, I_m and P_m: Measured values.			

Table 1: IEC61000-4-7 Accuracy requirements for current, voltage and power measurements

For emission tests, the upper class I is required if the emissions are near to the limit values. Since there is no reason emissions cannot be near the permissible limit values, all Harmonics and Flicker test systems will actually need Class I measurement accuracy in order to meet the requirements for product compliance certification.

4 ECTS2 System HFa Measurement Accuracies

Let us take this accuracy requirement information and see what it means for actual measurement results and repeatability of harmonic measurements between competing systems.

The first thing to note that while the accuracy specification in the IEC Standard looks reasonably good, it can often lead to large errors in actual measurement results.

An example will illustrate this.

Assume the H&F test system has a measurement range of 10Apeak to support testing of products with a nominal rms current of up 4 Arms. This supports products with a current crest factor of 2.5 or less.

> *Note that products with a current CF larger than 2.5 would be very unlikely to pass IEC61000-3-2 Current Harmonics limits so support for very large crest factors is not warranted as it would increase current measurement errors due to range.*

The maximum current measurement error allowed by the IEC standard for a small measured harmonic current is 0.15% of Inom so for a product that draws 4 Arms on a 10 Apeak measurement range, the allowable current measurement error is:

> 0.0015* 10 = 0.015 A or 15 mA.

The IEC61000-3-2 test standard Class limit for harmonic order no 39 is:

> (15 * 0.15) / 39 = 57.7 mA.

Thus, the ±15mA measurement error represents 26% of the allowable test limit.

Since this is a significant error, it can lead to discrepancies between results obtained for the same EUT on different H&F Test systems.

To address this problem, the Pacific Power Source ECTS2 H&F Test System measurement hardware was designed to meet a more stringent current measurement accuracy specification of 0.3% of limit ± 5mA.

Using this accuracy spec, the error on the same EUT for the 39th current harmonic would only be:

> 0.003 * 57.5mA + 5 mA = 0.17 mA + 5mA = 5.17 mA

This is about three times less than on a H&F system that just meets the IEC61000-4-7 Class I accuracy requirement.

> *Note that the Voltage measurement accuracy is not a critical as voltage harmonics are measured only to verify the AC source's suitability with respect to voltage distortion under non-linear loads. The ± 0.05% of Unom is more than precise enough for small voltage harmonics, especially as the test voltage is sinusoidal so the voltage crest factor is close to 1.414 and the nominal peak voltage range does not have to 2.5 times as is the case for the current measurement range.*

5 Pacific Power ECTS2 Series EMC Test Systems

The ECTS2 Series of EMC test systems was developed with the above considerations in mind and is already current on all IEC61000-3 test standards as of this publication.

6 Summary

Harmonic and Flicker EMC test systems represent a significant capital investment and must be 'future proof' to ensure a long useable working life to recoup this investment. As such, it behooves the buyer to consider not only present technical requirements that have to be met but also potential future requirements. A forward looking approach can avoid costly mistakes requiring possible retrofits or replacement before the economic life cycle of the test equipment has expired.

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