

APPLICATION GUIDE

IEC61000-4-7 Harmonic & Interharmonic grouping

Introduction

The IEC61000-4-7 standard represents guidance for instrumentation manufacturers regarding harmonic and interharmonic testing and measurement techniques relating to testing to the limits specified in IEC61000-3-2 and IEC61000-3-12.

IEC61000-4-7:2002+A1:2009 (Ed 2.1) introduced the concept of harmonic grouping and interharmonic grouping.

Harmonic Grouping:

Figure 1 below provides a general structure for the signal processing chain within a harmonic analyzer compliant to IEC61000-4-7.

This diagram features several outputs, in order to gain a better understanding of the signal processing involved within each stage of the acquisition chain. Pre-processing and sampling conversion is outside the scope of this application note.

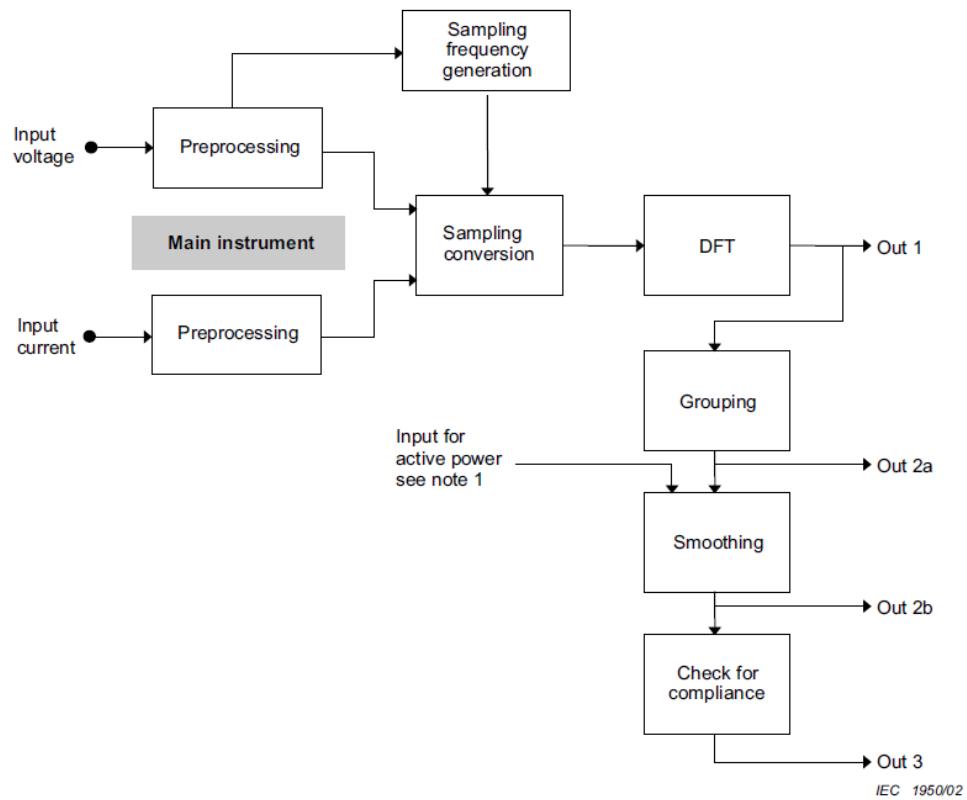


Figure 1.

OUT 1

Output 1 is the raw output of the DFT, this is a 5Hz resolution discrete Fourier transform output of the sampled data window.

Equation (1) in section 3.1 details the recommended Fourier transform

$$f(t) = c_0 + \sum_{m=1}^{\infty} c_m \sin\left(\frac{m}{N} \omega_l t + \varphi_m\right)$$

Equation 1.

Output 1 is passed to the Grouping operation, grouping is a source of much confusion in the industry as the IEC61000-4-7 standard describes both "Harmonic Grouping", as per section 5.5.1 and "interharmonic grouping, as per Annex A.

It is only "Harmonic grouping" that is required for the analysis of harmonic levels against the limits stipulated within IEC61000-3-2 and IEC61000-3-12.

"interharmonic grouping" is an informative analysis technique that at this time, is not required by IEC61000-3-2 and IEC61000-3-12. In the future, interharmonic grouping may have limits applied within future versions of IEC61000-3-2 and IEC61000-3-12 but at this time interharmonic grouping is for informative purposes only and is not required for compliance testing to IEC61000-3-2 and IEC61000-3-12.

Harmonic Grouping (Grouping)

The grouping process involves "the sum of squared intermediate lines between two adjacent harmonics according to equation 8". The important point to note within this statement is "adjacent", this means that the spectral component located in between each harmonic are squared and summed, with the adjacent spectral components being halved before squaring.

$$G_{g,n}^2 = \frac{C_{k-5}^2}{2} + \sum_{i=-4}^4 C_{k+i}^2 + \frac{C_{k+5}^2}{2} \quad \{50 \text{ Hz system}\}$$

$$G_{g,n}^2 = \frac{C_{k-6}^2}{2} + \sum_{i=-5}^5 C_{k+i}^2 + \frac{C_{k+6}^2}{2} \quad \{60 \text{ Hz system}\}$$

(8)

Equation 8.

This applies to all harmonics, including the 2nd harmonic.

Spectral components are spaced at 5Hz intervals, grouping for Harmonic 2 (H2) is indicated below for reference.

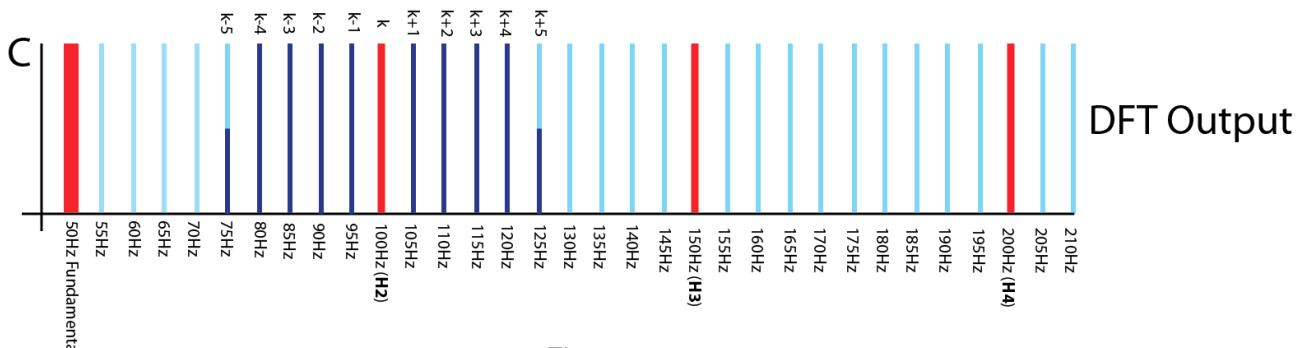


Figure 2.

Figure 2 provides a graphical illustration of the "harmonic grouping" performed within figure 1. It is clear that the interharmonic components $k-4$ (where k is the harmonic) to $k+4$ are not scaled before squaring, whereas $k-5$ and $k+5$ are scaled by 0.5 before the squaring operation.

Verification of correct Interharmonic functionality

Harmonic limits defined in IEC61000-3-2 and IEC61000-3-12 refer to the discrete harmonic series from a fundamental of 50Hz or 60Hz up to the respective 40th harmonic.

Measured harmonic values must conform to the harmonic grouping technique defined above and therefore a measurement instrument design should be proven to correctly measure interharmonic components within each harmonic group.

Design validation of the N4L PPA5500 series power analyzer range includes traceable verification of all 429 interharmonic frequency components (11 harmonic components per group for each harmonic from H2 to H40) at both 50Hz and 60Hz.

Illustrated below is the beginning and end of a 429-line ISO17025 traceable interharmonic test for a 50Hz system:

NEWTONS4TH,PPA5530,00850,2.67
Fluke.6105A.176162845.4.08

Result log

Verify response to 500mA individual 5Hz components at 230V 6A 50Hz

[155Hz to 1950 Hz]

Conclusion

1. IEC61000-3-2 and IEC61000-3-12 measurements must conform to IEC61000-4-7:2002+A1:2009 (Ed 2.1) testing and measurement techniques. Previous editions of this standard are withdrawn.
2. IEC61000-3-2 and IEC61000-3-12 limits define the harmonic group measurement not the harmonic components within a group.
3. Test equipment suppliers should provide evidence that their product design correctly measures all interharmonic frequency components.
4. The PPA5530 series has ISO17025 traceable validation of the harmonic measurement system confirming full compliance with IEC61000-4-7:2002+A1:2009 (Ed 2.1) harmonic grouping.

Note: Complete text files for both 50Hz and 60Hz harmonic grouping tests (429 lines each) available on request.