

POWER QUALITY MEASUREMENT. COMPARISON AMONG THREE INSTRUMENTS OF MEASURE OF DIFFERENT CLASS

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Abstract

In order to an accurate interpretacion of the measure results, it has been established an International Standard. The IEC 61000-4 defines the methods for measurement and interpretation of the results. This Standard is applied for power quality parameters in 50/60 a.c. power supply systems.

For each relevant type of parameter is described a measurement method. Every method makes possible to obtain reliable, repeatable and comparable results regardless of the compliant instrument being used and regardless of its environmental conditions.

During a measurement campaign, we conect the measurement device, for usually a week, on the PCC (Point of Common Coupling) of one factory. It is necessary to take into account the appropriate measurement methods for a successful performance. But if we use different instruments of measure at the same time, we will find differences between theirs results.

It is worthwhile asking if the differences between instruments are negligible or not.

In order to look for an answer to this question we have made different tests and measurements at the Electromagnetic Compatibility Laboratory and at the PCC of one factory with three different instruments: one of class A (Topas 1000) and two of B class (Unilyzer 812 and Memobox 300 smart). Previously we have compared two Unilazers 812 and also two Mamobox 300 Smart The results and conclusions of this comparison will be presented in this paper.

verifying compliance with standards, resolving disputes, etc.

If two different class A device measure the same signal, they will give matching results within a specified uncertainty. To ensure this, class A performance instrument requires a bandwidth characteristic and a sampling rate sufficient for the specified uncertainty of each parameters.

The figure below shows the Topas 1000 connexion scheme.

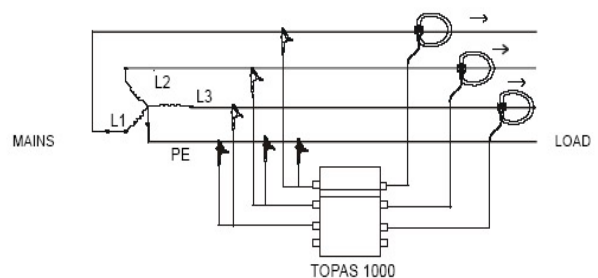
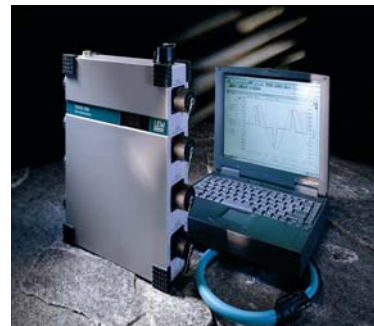


Fig. 1. Topas 1000 photo and connexion scheme

Key Words

Power Quality
Measurements Devices

1. Introduction

It exists two different classes of measurement devices according to the precision given.

Class A.

These devices are used when precise measurements are necessary. For example, for contractual applications,

For class A the range of influencing factors shall be complied with is specified in table 1.

Influence quantities	Range of variations
Frequency	42,5 Hz-57,5 Hz (50 Hz systems)
Voltage magnitude (steady state)	0% -200 % of U_{din}
Flicker (P_{st})	0 - 20
Unbalance	0% - 5%
Harmonics (THD) and interharmonics	Twice the values in IEC 61000-2-4, class 3
Main signalling voltage	0% - 9% of U_{din}
Transient voltages	8 kV peak
Fast transient	4 kV peak

U_{din} = declared input voltage (value obtained from the declared supply voltage, U_c , by a transducer ratio).

Table 1. Range of influence quantities for class A performance..

Class B.

This class of device may be used in applications where low uncertainty is not required. For instance statistical surveys, trouble-shooting, and other applications.

We used two different class B devices: Unilyzer 812 and Memobox 300 Smart.

The following figures show the connexion schemes of both instruments.

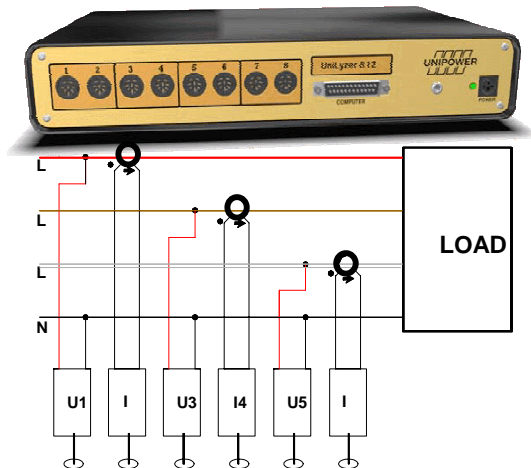


Fig. 2. Unilyzer 812 photo and connexion scheme.

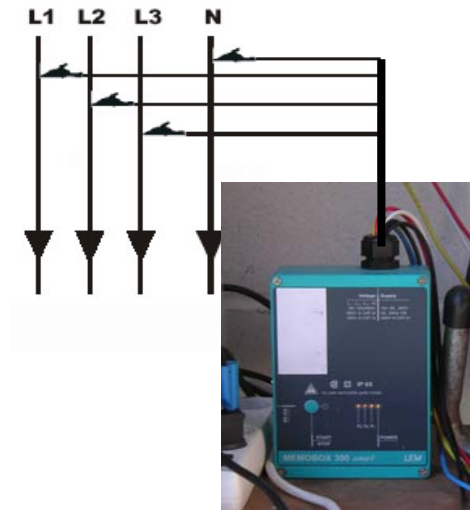


Fig. 3. Memobox 300 Smart photo and connexion scheme.

For class B the range of influencing factors shall be complied with is specified in table 2.

Influence quantities	Range of variations
Frequency	42,5 Hz - 57,5 Hz (50 Hz systems)
Voltage magnitude (steady state)	0% -150 % of U_{din}
Unbalance	0% - 5%
Harmonics (THD) and interharmonics	Twice the values in IEC 61000-2-4, class 3
Main signalling voltage	0% - 9% of U_{din}

Table 2. Range of influence quantities for class B performance.

2. Measurements Results

The way that the instrument fulfill a measure depends on the type of parameter.

A disruption in the electrical input signal can affect adversely the measurement and therefore the output of the instrument decrease.

The instrument manufacturer should declare how the measurement is affected by the disruption, although that is not usual.

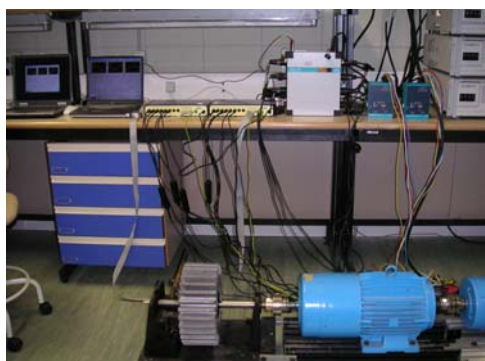


Fig. 4. Electromagnetic Compatibility Laboratory of Vigo University with the different instruments for make the comparison of the results of power quality measure.



Fig. 5. Inasus Factory with the different instruments for make the comparison of the results of power quality measure.

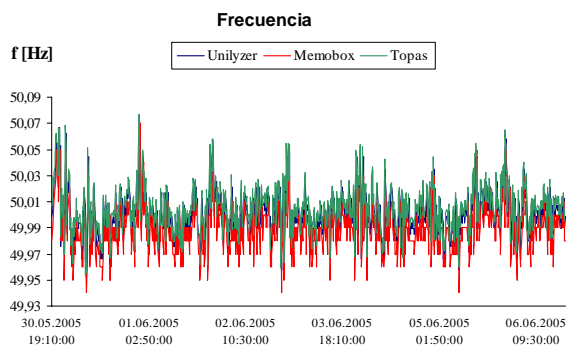


Fig. 6. Charts of the frecuece measure by the three instruments.

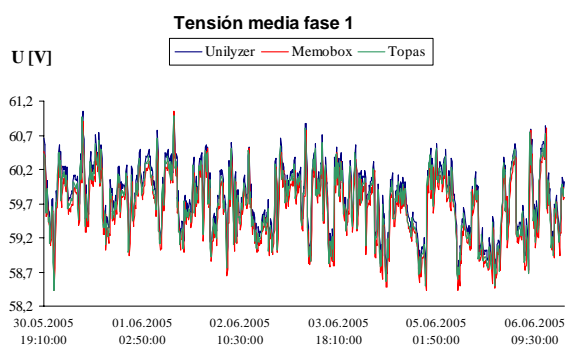


Fig. 7. Charts of the voltage measure by the three instruments.

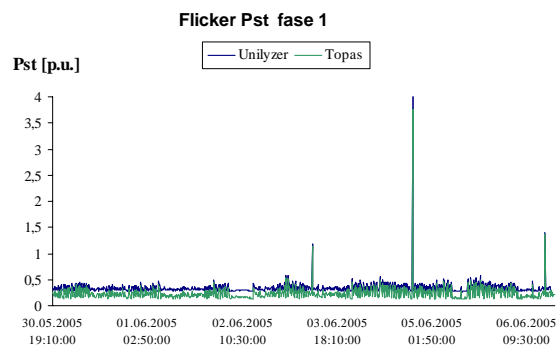


Fig. 8. Charts of the flicker measure by the three instruments.

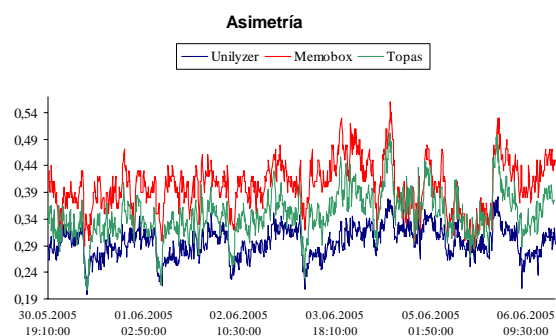


Fig. 9. Charts of the unbalance measure by the three instruments.

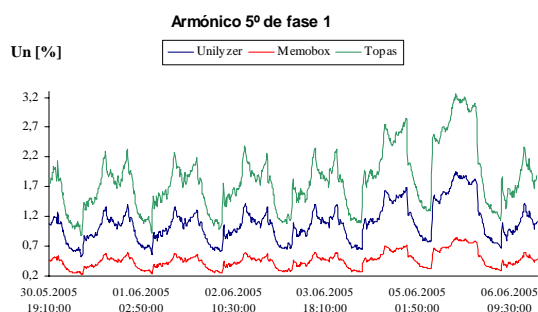


Fig.10. Charts of the 5th harmonic measure by the three instruments.

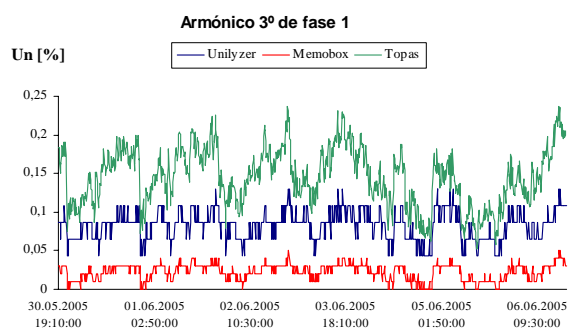


Fig.11. Charts of the 3rd harmonic measure by the three instruments.

3. Comparison of the results

We will use different errors indexes for make the comparison between the class A instrument (Topas 1000) and each of the others class B instruments (Unilyzer 812 and Memobox 300 Smart).

- Accumulative errors sum (CFE)

$$CFE = \sum_{t=1}^n (D_t - F_t) \quad (1)$$

Where:

D_t = Measurement value by Topas 1000 during a period of time t

F_t = Measurement value by Unilyzer 812 (or Memobox 300 Smart) during a period of time t

- Skew (B)

$$B = \frac{1}{n} \sum_{t=1}^n (D_t - F_t) \quad (2)$$

- Average absolute deviation (DAM)

$$DAM = \frac{1}{n} \sum_{t=1}^n |D_t - F_t| \quad (3)$$

- Average absolute percentage error (MAPE)

$$MAPE = \frac{100}{n} \sum_{t=1}^n \left| \frac{D_t - F_t}{D_t} \right| \quad (4)$$

	Errores en frecuencia				
	CFE	SESGO	DAM	MAPE	DCM
Unilyzer	4,9528	0,00492326	0,01235686	0,0247104	0,00025708
Memobox	15,4568	0,01536461	0,01992227	0,03983751	0,00057192

Table 3. Errors in the frequency measure by the two instruments of class B compared with the class A instrument .

	Errores en tensión media fase 1				
	CFE	SESGO	DAM	MAPE	DCM
Unilyzer	-97,6208	-0,0970386	0,17096541	0,28667069	0,05606453
Memobox	72,9276	0,07249264	0,19911213	0,33328968	0,07286027

Table 4. Errors in the voltage measure by the two instruments of class B compared with the class A instrument.

	Errores en flicker Pst fase 1				
	CFE	SESGO	DAM	MAPE	DCM
Unilyzer	-106,00275	-0,1053705	0,10539705	53,7544418	0,01201537

Table 5. Errors in the flicker measure by the Unilyzer compared with the class A instrument

	Errores en asimetría				
	CFE	SESGO	DAM	MAPE	DCM
Unilyzer	51,9080703	0,05159848	0,05203297	14,501478	0,00335005
Memobox	-53,852814	-0,0535316	0,05651226	16,776474	0,00396916

Table 6. Errors in the unbalance measure by the two instruments of class B compared with the class A instrument .

	Errores en el 3º armónico de fase 1				
	CFE	SESGO	DAM	MAPE	DCM
Unilyzer	63,532814	0,06315389	0,06316147	41,9628374	0,00467753
Memobox	123,99046	0,12325095	0,12325095	85,3269811	0,01603016

Table 7. Errors in the 3rd harmonic measure by the two instruments of class B compared with class A instrument .

	Errores en el 5º armónico de fase 1				
	CFE	SESGO	DAM	MAPE	DCM
Unilyzer	732,624202	0,72825467	0,72825467	40,1373321	0,57911948
Memobox	1357,48862	1,34939227	1,34939227	74,5911866	1,97202663

Table 8. Errors in the 5th harmonic measure by the two instruments of class B compared with class A instrument.

4. Conclusions

After a wide campaign of power quality measure at the Electromagnetic Compatibility Laboratory of Vigo University and Inasus Factory we can present the following conclusions:

a) The errors of the measures with the same type and model of instruments, between the two Unilyzers 812 and also between the two Memobox 300 Smart, are negligible, as we can check at the charts below.

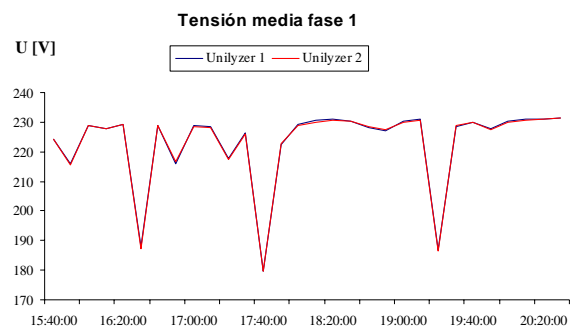


Fig.12. Charts of the comparison between Unilyzers.

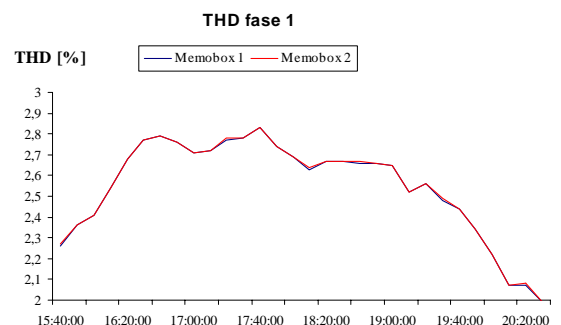


Fig.13. Charts of the comparison between Memobox.

b) The differences between a class A instrument (Topas 1000) and the class B instruments (Unylazer 812 and Memobox 300 Smart) could be accepted in the field of industrie. But in a laboratory where we need more accurate results this could be unacceptable.

c) Comparatively the precision of Unylazer 812 (a more expensive instruments) is better than the Memobox 300 Smart, nevertheless the Memobox 300 Smart is a much more compact instrument. Moreover it only needs a computer for initial programming (like Topas 1000) but the Unylazer 812 needs a computer along all the time of the measure.

On the other side the Memobox has a sampling frequency higher than Unylazer 812, consequently it can detect and register some overvoltages or voltage dips that the Unilazer can not. For instance, the overvoltage represented below was detected only by the Memobox.

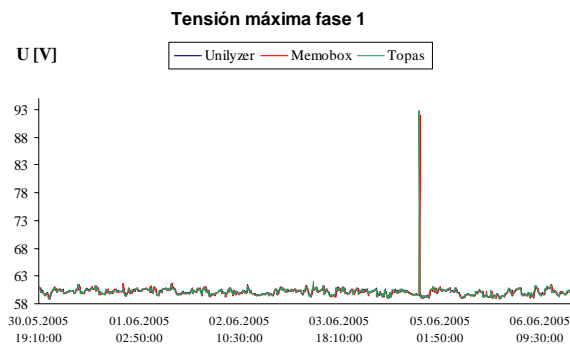


Fig.14. Charts of maximum voltage.

d) We need take into account another important element for compare the errors: the measurements ranges of the probes. The wider measurement ranges, higher errors.

e) The measurement transducer and their associated uncertainty must be also considered.

Acknowledgement

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References

- [1] F. Oliveira, A. Madureira and M. P. Donsión, “Experimental Study of Power Quality in Wind Farms”, in ICREPQ’04, March 2004.
- [2] IEC 61000-4-30 International Standard, Reference number: CEI/IEC 61000-4-30; 2003
- [3] F. Oliveira, A. Madureira and M. Pérez Donsión “Power Quality Impact of Wind Farms on Domestic and Industrial Facilities”, in ICREPQ’05, Zaragoza, March 2005.
- [4] M. Pérez Donsión, F. Oliveira, A. Madureira “Power Quality Considerations: Measurements at a Sawmill”, 9th Spanish Portuguese Congress on Electrical Engineering, Marbella (Spain), 2005.